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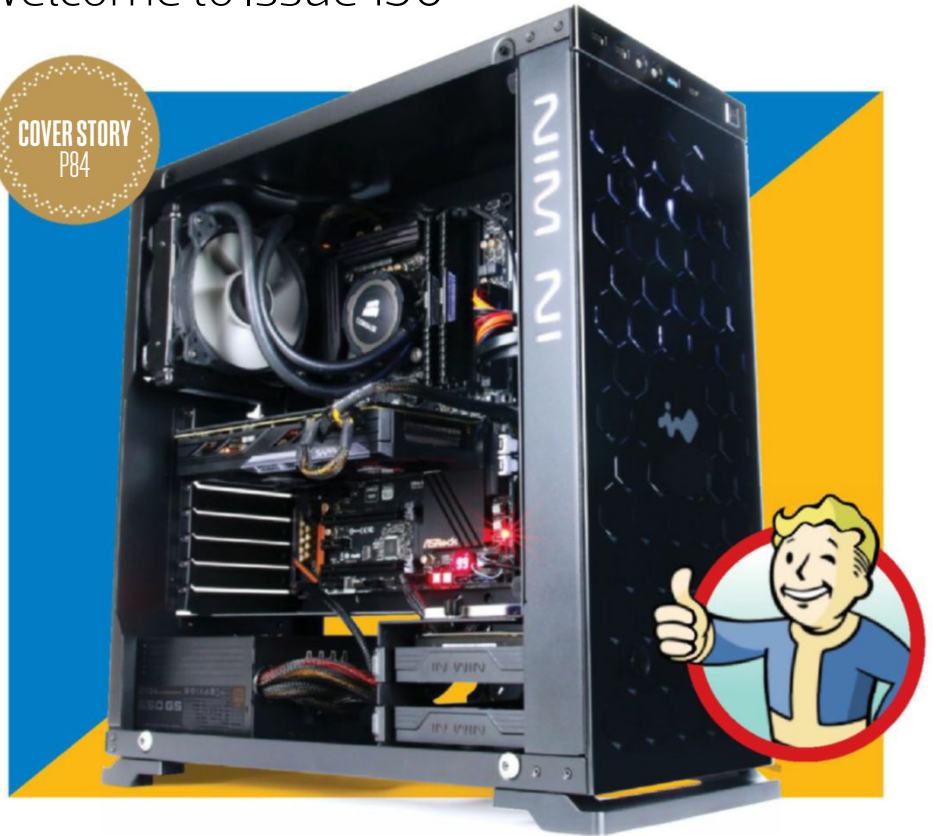
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84 Fallout 4 special

If you received a copy of Bethesda's latest post-apocalyptic open-world epic for Christmas, or if you're thinking of buying it, then we have all the information you need to make sure you have the right gear. For starters, we've developed a new Fallout 4 benchmark, which we've tested on loads of current GPUs on p90, while also analysing some of the game's advanced graphics settings.

Also, if your current setup is starting to crawl to a halt in new games such as Fallout 4, and you're thinking of building a new gaming rig for under a grand, then take a look at our build feature on p84. Here, we show you how to assemble an overclocked Skylake PC that can play Fallout 4 at Ultra settings at 1080p, and at High settings at 2,560 x 1,440, and with a great-looking case and solid state storage too.

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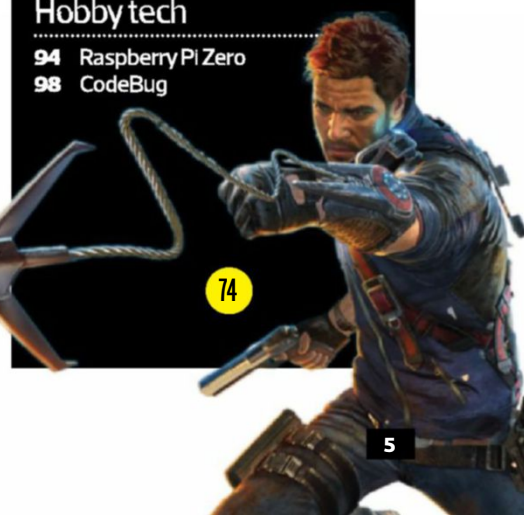
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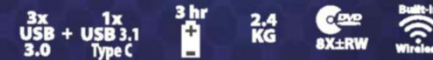
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BEN HARDWIDGE / FROM THE EDITOR

TURNING BACK THE CLOCK

Ben Hardwidge is delighted to see ASRock's Sky OC tech bringing overclocking back to its rule-breaking roots

I'll let you into a little secret. Most of the time, my Core i7 CPU isn't overclocked. I bought a K-series chip, of course—I want the option to push my CPU to its limits for benchmarking, or if I'm running software that really needs it. However, it runs at stock speed for over 90 per cent of the time. It's not so much that there's no longer any need for overclocking, but that the top-end K-series CPUs are ironically the chips that need to be overclocked the least. They're already powerful enough for most people.

The chips that really benefit from overclocking are the cheap ones. When I first got into overclocking, back in the 1990s, neither Intel nor AMD approved of overclocking. In fact, they fought hard against it, which is why we ended up with locked multipliers in the first place. At this time, overclocking wasn't a willy-waving exercise for people with the most expensive components, but a way for cash-strapped enthusiasts to effectively get the performance of an expensive CPU for the price of a cheaper one.

We now have CPUs that Intel and AMD have given us their blessing to overclock but, with the exception of the aging Pentium G3258, they're all at the pricier end of the scale. Unless you're using these CPUs for very processor-limited loads, though, which generally doesn't include gaming, you get little benefit from the clock speed boost.

As such, I'm delighted to see that ASRock has found a way to overclock non K-series CPUs using the base clock (see p15). At the time of writing, several other motherboard makers had revealed similar plans too. It's debatable how long this feature

will be available, and whether Intel will be happy about it continuing, but it's much more in the spirit of overclocking than tweaking expensive unlocked CPUs.

Overclocking should be about breaking the rules, and using your expertise to get performance that's genuinely useful, rather than superfluous. The big deal about being able to overclock non-K series CPUs isn't that you can buy a Core i7-6700 instead of a Core i7-6700K, but that you can buy a much cheaper Core i3-6100 for less than £100 and, according to ASRock, push it to 4.4GHz. Or, if you want more multi-threading power, you could buy a lower-clocked Core i5 chip for £55 less than the 6600K, but overclock it to the same frequency as the 6600K.

Given that, even now, few games make extensive use of more than two CPU cores, such a setup would provide a foundation for a great budget gaming rig when it's overclocked. Combine it with a cheap Z170 motherboard, 8GB of memory and a Radeon R9 380 card and you'll get a decent Skylake gaming system, complete with Hyper-Threading, for a surprisingly low price.

Unless you're into competitive benchmarking, or you regularly run software that responds well to high CPU frequencies, there isn't really any point in overclocking an expensive and already powerful CPU. In fact, doing so will just involve increasing the speed of your cooling fans, creating more noise, while also bumping up your electricity bill. This new era of base clock overclocking has the potential to bring overclocking back to its roots, opening it up to people without masses of money to spend, and that's what it should be all about. **CPG**

Ironically, K-series CPUs are the chips that need to be overclocked the least

Ben Hardwidge is the editor of Custom PC. He likes PCs, heavy metal, real ale and Warhammer 40,000. editor@custompcmag.org.uk [@custompcmag](https://twitter.com/custompcmag)



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RICHARD SWINBURNE / VIEW FROM TAIWAN

THE STICKER PROGRAM

Seeing OCUK PCs in Game stores excites Richard Swinburne much more than Lenovo boxes with Razer badges

Lenovo and Razer recently announced a plan to build gaming PCs together. On the surface, this new relationship looks good. Razer is a long-time specialist in this field, and this popular PC gaming brand sponsors numerous eSports teams and stars. Razer has even dabbled in building swanky gaming laptops with its Blade range. However, while the Blade systems have generally been well received by the press, they're expensive, only available in a few select regions and as a result, they've sold in limited numbers.

This partnership with Lenovo brings huge buying power for components, resulting in cheaper costs, and it also brings more manufacturing capacity and global sales reach. Razer's gaming credibility and Lenovo's large-scale manufacturing abilities makes it look like a win-win partnership that will enable both firms to compete with established gaming laptop manufacturers.

However, Lenovo has little experience with gaming gear, or with PC enthusiasts; it's seen as a maker of corporate steel and plastic boxes. You use a Lenovo machine for spreadsheets, rather than playing Splinter Cell. Meanwhile, Razer appeals to the complete opposite end of the spectrum: a premium-focused gaming brand that pays careful attention to design and spec, crafting high-end (and often expensive) hardware. It's hard to see how the two brands will complement each other – Lenovo doesn't have much credibility in the world of PC enthusiasts and gaming.

So, are these new systems going to be specced and designed according to the acute gaming insights of Razer's team, or will they be Lenovo boxes sporting Razer badges? In the announcement, the two companies said they planned to 'co-brand and co-market special Razer Edition models of Lenovo's Y series gaming devices', and that 'Lenovo will employ

its system design and engineering expertise, while Razer will enhance the immersive experience for gamers'. Oh dear, they're going to be Lenovo boxes with Razer badges.

Gaming and enthusiast credibility is *really* difficult to establish. At least Alienware's team is still fully independent of Dell, but even then, how many Alienware machines are seriously considered by PC enthusiasts, seen at LANs or talked up enthusiastically online?

It's the independent system builders, such as Scan and Overclockers (to name just two), that are arguably a bigger attraction to PC enthusiasts and top gamers. The value of a hand-built, fully considered system (both inside and out) that's built and designed by fellow enthusiasts, and constructed using

known and well-reviewed components, is a big attraction. System builders follow trends quickly; they're trusted to put the kit together properly, and their customer service is often faster and more personal than the service from a large corporation.

Comparatively, the recent announcement of a deal between Overclockers and Game (see p15), bringing OCUK's gaming rigs to the high street, shows how such a partnership could really work. OCUK has carved out plenty of credibility among enthusiasts and gamers over the past 15 years, as both an established system builder and component retailer, while Game has been serving gamers on the high street for over a decade. For me, what's exciting about this deal isn't so much the potential for direct sales of OCUK PCs in high street stores, but the idea that we can get properly built and stylish gaming PCs into the view of the wider public, perhaps enticing console gamers back into PC gaming. It's a great opportunity to reach out to a new generation of gamers, and boost interest in PC gaming and its surrounding community. **GPC**

Gaming and enthusiast credibility is *really* difficult to establish

Richard has worked in tech for over a decade, as a UK journalist, on Asus' ROG team and now as an industry analyst based in Taiwan [@Bindibadgi](#)

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Letters

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How important is efficiency?

Is efficiency important? No, at least not as important as noise and heat. I have a very efficient PSU, but it's also very loud. I'll replace it with something quieter the first chance I get – if it's less efficient, then so be it – that may well be the case, given that my current one is already 80-85 per cent efficient. Power efficiency may be an issue if you expect your Bitcoin mining to pay for itself, but gaming is an expensive and indulgent hobby anyway, price be damned. Families are expensive to run at the best of times, so saving a few beans here or there will just be soaked up elsewhere anyway. Good pie test, by the way. Cheers, and merry Christmas to all in Custom PC Towers.

PRAXIS22

Ben: You'd be surprised at the quality of most branded PSUs these days. Thanks to the 80plus initiative, virtually none of them has efficiency below 80 per cent, and the vast majority of them are much more efficient than 80 per cent now. What's more, there are plenty of efficient PSUs with quiet fans and semi-passive cooling these days, so they're quiet too. I reckon you'll be able to find the best of both worlds pretty easily.

I find myself in total agreement with your last editorial about efficiency. I'm not sure whether we're the only two, although I would imagine that a lot of readers are power users, for whom performance comes first and foremost. Apologies to other readers if my thoughts are in the minority!

Normally there's a trade-off between power and efficiency. However, the recent designs from



Many of the latest PSUs, such as Corsair's superb RM750i, aren't just very efficient, but they're also very quiet

Intel and Nvidia have shown how it's possible to now have both. Also, look at your recent power supply tests – every PSU's efficiency was above 80 per cent. My preference is for low power consumption and heat generation whenever possible. Indeed, my Core i7 Nehalem CPU hasn't been overclocked because its performance with my level of gaming and general use seems fine with the stock speed.

Overclocking would significantly increase the power draw and heat generated – for performance that I don't really feel I need.

I've also postponed a long overdue upgrade to my system, due to AMD's plans to issue newly designed GPUs and CPUs this year. I find this prospect exciting, and they'll hopefully be worth the

competitors' power draw, then I will be buying them.

RICK BILLSON

For a long time, I was a fan of Intel and Nvidia, from my first 1GHz build until just a few years ago, when you could get more performance for your pound from AMD parts. I'm currently running an AMD FX-8350 CPU with a Radeon R9 390, and I'm beginning to feel I've reached the AMD performance ceiling, and that AMD is tending to push its components very hard, making them hot and inefficient, to try to compete with Intel and Nvidia on performance. It feels like factory overclocking; could I buy similarly priced Intel and Nvidia parts, overclock them to similar thermal and power limits, and get more performance for my money?

I build computers for people as a hobby and I'm now steering people towards Intel and Nvidia for the first time in years. When I can afford to upgrade, I'll be going that way too – the only reason I recently upgraded to an R9 390 was for the 8GB of memory, when Nvidia's GTX 970 cards could only offer 4GB of memory – I'll actually use the memory on a daily basis for GPU compute tasks.

I'm self-employed and disabled, so I effectively live below the minimum wage, and my PC is folding all night every night (it's water-cooled to keep the temperatures sensible), so the running cost is absolutely a factor. With AMD components turning so much more of my income into heat, I can't recommend them, except in cases such as mine when double the RAM makes a real difference to productivity.

MARK VARLEY

Our graphics test rig draws 437W from the mains at load with an AMD Radeon R9 390 installed, compared to just 266W with an Nvidia GeForce GTX 970 installed



wait. If the new products match the performance of Intel and Nvidia's equivalents, but are still power-hungry, I won't be buying them. However, if they're not quite as good performers, but beat their

You were spot on with the Co-op mince pies. Lovely!

Ben: AMD's gear hasn't been great in terms of heat and power draw for a long time now, sadly, but times change, and we've seen swap-overs in the past. It wasn't that long ago that Nvidia's Fermi GPUs were considered hot and power-hungry compared with the AMD equivalents, and likewise with Intel's NetBurst CPUs going even further back. The question is whether AMD can pull out two blinding new architectures after losing so much money over the past few years. I like Mark's simile about factory overclocking; it's not far from the truth. AMD desperately needs new CPU and GPU architectures that are not only competitive in terms of performance, but also in terms of power consumption and heat output. I really hope it can come up with the goods over the next year.

Solder of fortune

As an ex-electronics engineer, it's been a while since I used a soldering iron in earnest, and I recently needed to replace a MOSFET on a motherboard, and replace an 8-pin SMT chip on a daughterboard for



Soldering stations such as this Tenma unit constantly monitor the iron's temperature, adjusting the output to keep it stable

my 3D printer. My soldering iron was totally inadequate for heating up the ground plane for the tab on the FET, and the tip was too large for the fine-line SMT chip. I was therefore fascinated by the Variable temp iron review, which looks great, although it's not quite what I would need. I was wondering if Hobby Tools could be a regular column. Modding is a big part of Custom PC, as well as overclocking, and it would be great to see reviews and comparisons of hobby drills, bending equipment and irons alongside the custom parts we see regularly.

CENYDD SMITH

PS You were spot on with the Co-op mince pies. Lovely!

Ben: I'm not sure about a regular section, but I do think it's about time we



Twitter highlights

Follow us on Twitter at @CustomPCmag

richardnpaul My mounting of an attack on the leaderboard starts soon. E5-2670-v1 '2 are on their way from the US, motherboard too.

Ben: Excellent, we look forward to seeing your scores!

georgebaily Hah, see what you did there with facing page ad.

Ben: Ha, that was honestly



completely accidental!

planetming Unbelievable wiring suggestion without soldering @CustomPCMag

Antony: My apologies for the poor part of this guide. I've

completely redone that part of the guide in this issue, using crimped-on spade connectors and heatshrink wrap following some research (see p106).

wellrandom Finally got the wife reading @CustomPCMag, but it's just the mince pie megatest :(Now we really want a mince pie. Off to the Co-op ...

CORRECTIONS & CLARIFICATIONS

In our mince pie megatest (Issue 149, p30), we said: 'gone is last year's Snowy Lodge brand, replaced with Favorina', in our review of the Lidl Favorina pie. However, Lidl has clarified that the Snowy Lodge range is still very much still available in its stores, and that the Snowy Lodge six-pack won a Which? Best Buy this year. The Favorina brand is Lidl's more budget-friendly pie.

did another modder's toolkit feature, where we review some of the essential tools over a few pages. I'll see if we can sort one out later in the year.



Mincing your words

As always, your mince pie megatest in the last issue was a great read. However, the issue doesn't hit the shelves until December each year, by which time we're well into the mince pie eating season. Would it be possible to move it to the issue that goes on sale in November next year, or are the pies not available in the shops early enough for you to make the deadline for that issue?

ANDREW LEVICK

Ben: The pies are definitely available in time – they usually go on sale at a ridiculous time in September, meaning some of them pass their sell-by dates before Christmas. Point taken, anyway – we'll do the test earlier next year so you can start the mince pie eating season as soon as possible! **GPG**

The Waitrose Duchy Organic – winner of our 2015 mince pie megatest



WHEN'S THE NEXT MAG COMING OUT?

Issue 151 of Custom PC will be on sale on Thursday, 11 February, with subscribers receiving it a few days beforehand.



Send your feedback and correspondence to letters@custompcmag.org.uk



TRACY KING / SCEPTICAL ANALYSIS

HOW TO SPOT A RIP-OFF

Tracy King shares her tips for avoiding Kickstarter tech scams

I read tonnes of customer reviews while compiling my Christmas wish list this year. This sort of consumer feedback, made possible by the Internet, theoretically democratises retail in a way that previously wasn't really possible. Beforehand, we'd mostly choose a blender by which brand we trusted. Brands still play a part (the Amazon bestsellers in most categories are household names), but increasingly, customers are prepared to take a punt on lesser-known names.

Kickstarter is a fine example. Although larger brands such as Double Fine or MST3K attract the most investment, when it comes to tech, there's a Wild West of new and occasionally shady names at which we can throw our money.

Take Shield Apparel, a company I hoped was a spoof but appears to be genuine. It's raking in tens of thousands of pounds on Kickstarter for a tinfoil hat. An actual tinfoil hat, disguised as a fleecy beanie. The hat 'protects' the wearer from 'electromagnetic smog' caused by mobile phones and Wi-Fi; as you know (because I'm always banging on about it), this isn't a real thing. The Kickstarter page and accompanying video is written in dodgy English and contains several of the red flags associated with scams (and spoofs). With that in mind, here's Tracy's Handy Guide To Knowing When Something Is A Rip-off.

1. Does it solve a problem you didn't know you had? This is usually the case for health products, such as the Shield hat. You weren't aware that your baby's brain was being fried by the microwave, but now that you do know, you're going to need this expensive gadget/pill/copper bracelet.

2. Does it solve a problem everyone has? A great example is 'tired all the time'. I bet you're nodding because, yep, you're tired all the time. Me too. Everyone is. But if you buy this tablet, you'll have the energy of a rabbit.

Beware of anything that claims to be 'quantum' unless it's from CERN

3. Does the marketing contain deliberately sciencey-sounding jargon? Beware of anything that claims to be 'quantum' unless it's from CERN. Likewise, 'electromagnetic' and 'radiation' are scary words that don't mean anything in the context of selling you protective gear for ten quid.

4. Is it a testable claim? You don't need to be a scientist to know that some claims, such as 'I am a wizard' aren't testable, while other claims, such as 'I can heal your broken leg with my hands' are. The Shield hat bump makes several testable claims, saying it's 'antibacterial, antimicrobial, antiradiation, antiodor, antistatic, and radar and infrared invisible', but it doesn't supply any actual evidence to support them.

An antiradar hat will be useful for when I want the illuminati to think I'm a headless zombie though.

5. Is the writing poor quality? This tip isn't just handy for identifying scammer emails (which use bad grammar deliberately to weed out smarter recipients). Any sincere company that makes a product will employ professional copywriters and marketers to write blurb for each regional territory.

'We are here for the same reason like everyone else,' declares Shield Apparel. Okay then! That totally makes sense and I trust you with my money and health!

6. Is the evidence independent? Sometimes a product will give citations, but when you dig a little further, the tests are funded by commercial entities or even the retailers themselves.

The Shield hat, in my opinion, falls afoul of advertising standards and is unlikely to see the end of its campaign, but you can always make your own with the leftover silver foil from your Christmas dinner. **GFC**

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming [@tkingdoll](#)

Incoming

We take a look at the latest newly announced products

Corsair introduces low-profile liquid cooler

The need to find space for a radiator mount has previously limited all-in-one liquid coolers from being installed in very small mini-ITX rigs and low-profile HTPC systems, but Corsair has revealed its intentions to conquer these areas with its liquid-cooling systems too. The company's new H5 SF cooler squeezes the radiator and cooling fan into a flat unit that sits on top of a mini-ITX motherboard, without the need to incorporate case fan mounts. The unit measures 84mm tall and features an integrated low-noise 120mm blower fan, which Corsair says will effectively draw heat from other components on the motherboard, such as the VRMs, and exhaust it out the vents at the back. The H5 SF is available to order for £80 inc VAT from www.corsair.com now.



Game brings Overclockers PCs to the high street

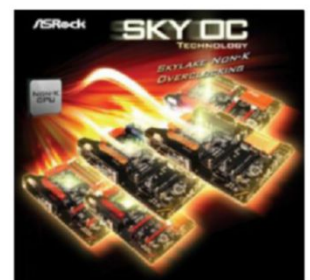
Enthusiast system builder and retailer, Overclockers UK, has just announced a deal with high street video game store, Game, which will see Overclockers' gaming PCs on sale in Game's high street stores. The deal will see an interactive Overclockers UK display stand being introduced to several Game stores, starting with the Basingstoke and Trafford Centre (Manchester) shops, and expanding into eight more Game stores later.

'The combination of Overclockers UK's expertise and the retail estate of Game is the ultimate way to introduce and demonstrate gaming hardware to a wider audience,' commented Overclockers UK's executive director, Steve Ling. The PC range starts at £560 inc VAT for an OCUK Gambit machine with a GeForce GTX 950 and an AMD FX-860 CPU, and goes up to Skylake systems with liquid coolers and GTX 980 Ti cards, with a variety of configurations in between. See www.game.co.uk/pcgaming for more information.

ASRock overlocks non-K Skylake CPUs

Skylake overclocking on a budget has just been enabled, thanks to ASRock introducing a way to overclock non-K series Skylake chips using the base clock. Overclocking Intel's latest chips usually requires use of a CPU with an unlocked multiplier, such as the Core i7-6700K, but in December 2015, ASRock officially announced its Sky OC system, which is available via a BIOS update and effectively enables you to overclock the base clock on much cheaper Skylake CPUs.

According to ASRock, the only catch is that the system disables the on-board GPU, but that won't be a worry for anyone wanting to build a budget gaming system with a discrete graphics card. The system also disables dynamic frequency adjustment using Intel's Turbo Boost tech. Using an ASRock Z170 Pro4, ASRock says it's been able to overclock an Intel Core i5-6400 from its stock clock speed of 2.7GHz to 4.3GHz, by overclocking the base clock from 100MHz to 160MHz. The company says it's also overclocked a Core i3-6100 to 4.4GHz using Sky OC. We'll be taking a closer look at overclocking non-K series CPUs in the next issue of *Custom PC*, so watch this space.



Reviews

Our in-depth analysis of the latest PC hardware



Reviewed this month

Corsair Scimitar RGB p17 / AMD Radeon R9 380X p18 / Fractal Core 500 p20 /
Gigabyte Z170MX-Gaming 5 p24 / MSI Z170A SLI Plus p26 / Roccat Kova p28 / Custom kit p30

GAMING MOUSE

Corsair Scimitar RGB / £70 inc VAT

SUPPLIER www.scan.co.uk / MODEL NUMBER CH-9000091-EU

Multi-button thumb pads on mice can be hit or miss affairs; they can be uncomfortable to use and it can be tricky to get used to them as well. However, Corsair has employed a couple of nifty features with its new Scimitar RGB mouse that really make it stand out. Firstly, the 12 thumb buttons grouped together on the side are clearly numbered and backlit, and while they're positioned at slightly differing angles, they're all roughly the same size and have an alternating textured finish.

The most useful feature, though, is that the entire group of buttons sits on an adjustable slider, so you can move them backwards and forwards. The pad is fixed out of the box, but there's a small hex screw in the base that you can loosen using an included tool. It makes a big difference to gamers with smaller or larger than average hands, as you can fine-tune the position to ensure all the buttons are within easy reach.

However, there are no standard thumb buttons and, strangely, none of the buttons on the pad is pre-assigned as forward or back buttons either. However, Corsair's excellent Utility Engine software makes it a simple task to assign these functions

yourself. You also get twin dpi toggle switches, allowing you to flick up and down through the sensitivity range of pre-set dpi options. These settings are fully configurable in the software too, in 100dpi steps with independent X and Y axis tuning.

Meanwhile, the 12,000dpi optical sensor is a hefty step up from the 8,200dpi sensor in the similar-looking Sabre Optical, and it provides a smooth, predictable feel, although resolutions in this extreme range are rarely genuinely useful for gamers.

The Scimitar's 147g weight also makes it pretty heavy, especially compared to the Sabre Optical's 100g. The Teflon feet do a good job of dealing with hard or material-based surfaces, but the added weight is certainly noticeable on the latter. You get used to it quickly, though, and when combined with the lag and acceleration-free sensor, the Scimitar is a very pleasant mouse to use. There are ring and pinky

finger supports too; however, like the Sabre Optical, the Scimitar isn't a large mouse and anyone with long fingers, or gamers who prefer a palm grip, may find their fingertips dangling over the end of the main buttons.

There are several different lighting zones too, with full RGB colours available. You can allocate different colours based on the current profile, and there's a dpi sensitivity indicator too. The software also allows you to record macros and assign them to specific buttons, as well as reassigning any of the buttons on the mouse. The use of game profiles also means that, once they're set, you probably won't have to fiddle around in the software again, as profiles can be loaded according to the game being played

Conclusion

The Scimitar is solid, flexible and comfortable enough to be used as both an everyday and FPS gaming mouse, as well as in the MMO and MOBA-style games for which it's designed. It isn't cheap, but if you need all those extra buttons, the Scimitar offers a winning combination of performance, quality and flexibility.

ANTONY LEATHER

/SPECIFICATIONS

Sensor 12,000dpi optical

Connection Wired, USB

Cable 1.8m, braided

Materials Plastic

Extras Adjustable thumb buttons

DESIGN
36/40FEATURES
33/35VALUE
21/25

OVERALL SCORE

90%

VERDICT

A solid mouse with a mass of thumb buttons, decent performance and loads of flexibility.

GRAPHICS CARD

AMD Radeon R9 380X / £190 inc VAT

SUPPLIER www.scan.co.uk

Through all the renames and rebrands it can be hard to keep track of AMD GPUs. Two GPUs that once sat at the top – the Radeon HD 7970 and HD 7950 – were later rebranded as the R9 280X and R9 280 respectively. These GPUs were then redesigned using AMD's third-generation Graphics Core Next architecture (GCN 1.2) and the result was the Tonga GPU, which was used in the R9 285 (since rebranded as the R9 380), but only in a partially disabled state. Now, with the new R9 380X, we finally have a fully enabled Tonga GPU. It has the same core count as the old HD 7970/R9 280X, but also has a more parallel layout and other optimisations from GCN 1.2.

The R9 380X has the same front end as all GCN 1.2 GPUs, with one Graphics Command Processor and eight Asynchronous Compute Engines, which give the card hardware-accelerated support for asynchronous shaders, a feature of DirectX 12 that enables compute and graphics tasks to be performed together, using resources more efficiently.

Tonga is divided into four Shader Engines (SEs), each of which has its own geometry processor and rasteriser. Each SE is also home to eight Compute Units, giving the R9 380X a 14 per cent bump in the stream processor and texture unit counts, which stand at 2,048 and 128 respectively.

Otherwise, the R9 380X and R9 380 are mostly identical. There are eight ROPs per SE in both GPUs for a total of 32. There are also the same four memory controllers making up a 256-bit wide interface. One difference is that the R9 380X is only offered with a 4GB frame buffer, while the R9 380 has both 2GB and 4GB SKUs available.

Reference clock speeds of the R9 380X stand at 970MHz on the core (same as the R9 380) and 1.425GHz (5.7GHz effective) for the memory, which is a slight bump over the

R9 380's 5.5GHz effective speed and takes the maximum bandwidth from 176GB/sec to 182.4GB/sec. That said, as usual, there's no true reference card made by AMD. The one we're using for this review is the Sapphire R9 380X Nitro, which ships with a 1,040MHz core and 6GHz memory. However, as always, we've downclocked the card to reference speeds to establish baseline performance.

Just like the R9 380, the 380X also has a typical board power rating of 190W, with two 6-pin PCI-E power connectors.

All the latest AMD features are supported too: CrossFire over PCI-E, TrueAudio, FreeSync, Virtual Super Resolution and Frame Rate Target Control. Sadly, AMD cards don't yet have

hardware-level support for H.265 content or HDMI 2 – this card has two DVI ports, one HDMI 1.4a connector and one DisplayPort 1.2 socket.

Our Sapphire Nitro sample uses the company's Dual-X cooler, featuring two 100mm fans that turn off under low load. Some hot air will be exhausted into your case, but lots will be directed through the rear I/O panel. The card is very well built, with a metal shroud and metal backplate that aids cooling and adds rigidity. The cooler uses four 6mm copper heatpipes and directly cools the GPU, memory and VRMs.

Performance

In terms of average frame rates, the GTX 970 is nearly 30 per cent quicker than the R9 380X, but in turn, AMD's new GPU beats the GTX 960 by 17 per cent at 1080p and 23 per cent at 1440p. It's 8–9 per cent quicker than an R9 380 too. Minimum frame rates are more important, however, and they reveal a card that's excellent for 1080p gaming, never dropping below 30fps.

AMD says the Radeon R9 380X is built for gaming at 2,560 x 1,440, and it has a definite edge over the Radeon R9 380 at this resolution, taking the 380's borderline playable minimums in Shadow of Mordor and The Witcher 3 and pushing them above 30fps. However, its Fallout 4 minimum of 20fps at this resolution is too choppy, and its 27fps minimum in Crysis 3 is still only borderline playable. The extra grunt of the GeForce GTX 970, however, makes it noticeably smoother in both cases. Nvidia leads the way regarding efficiency too, with the GeForce GTX 970 consuming significantly less power than the Radeon R9 380X, despite being considerably faster.

The 380X is a great overclocker though. With the power limit increased by 20 per cent and with an extra 100mV of voltage, our card reached a 1,220MHz stable core – over 25 per cent beyond the reference frequency, and 17 per cent over Sapphire's factory clock.

We could only push the Radeon R9 380X's memory up to 6.1GHz effective, though, being limited by AMD's memory



/SPECIFICATIONS

Graphics processor AMD Radeon R9 380X, 970MHz
Pipeline 2,048 stream processors, 32 ROPs
Memory 4GB GDDR5, 5.7GHz effective
Bandwidth 182.4GB/sec
Compatibility DirectX 12, OpenGL 4.5, Mantle, Vulkan
Outputs/inputs Dual-link DVI-D, Dual-link DVI-I, HDMI, DisplayPort
Power connections 2 x 6-pin
Size 238mm long, dual-slot



controllers. Performance improved by up to 16 per cent with this overclock, even nipping at the heels of the GTX 970 (although that card also overclocks very well). Sapphire's cooler did a good job as well, staying quiet throughout testing and keeping temperatures well in check. There was no unpleasant coil whine from the card either.

Conclusion

AMD's best graphics weapon is its bang per buck, which makes the R9 380X a good offering. It starts at £190 inc VAT, putting it on the right side of £200 relative to the immediate competition. In terms of the best value card for 1080p (and some 2,560 x 1,440) gaming, the R9 380 still leads the way, while the GTX 970 remains the best choice for smooth 2,560 x 1,440 gaming.

Even so, the Radeon R9 380X fills the gap between these cards neatly if you have a little more money to spend, and at a price where Nvidia doesn't have an equivalent. The

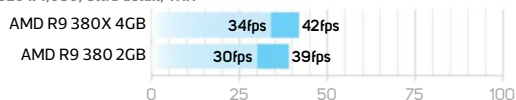


Sapphire Nitro card is a fine choice for an R9 380X too – it retails without any price premium, despite core and memory overclocks, and the cooler is solid too.

MATTHEW LAMBERT

FALLOUT 4

1,920 x 1,080, Ultra detail, TAA

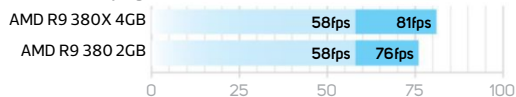


2,560 x 1,440, Ultra detail, TAA

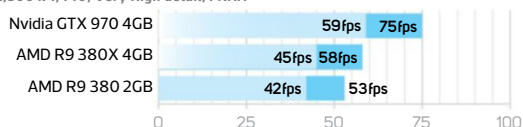


GRAND THEFT AUTO V

1,920 x 1,080, Very High detail, FXAA

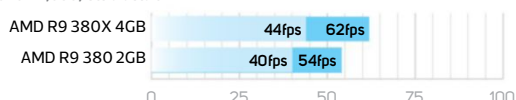


2,560 x 1,440, Very High detail, FXAA

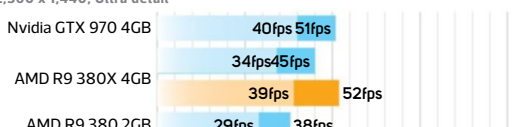


MIDDLE EARTH: SHADOW OF MORDOR

1,920 x 1,080, Ultra detail



2,560 x 1,440, Ultra detail



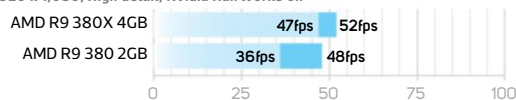
Stock speed min Stock speed avg Overclocked min Overclocked avg

SPEED
29/40
VALUE
36/40
FEATURES
16/20

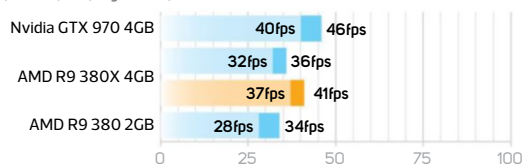
OVERALL SCORE
81%

THE WITCHER 3: WILD HUNT

1,920 x 1,080, High detail, Nvidia HairWorks off

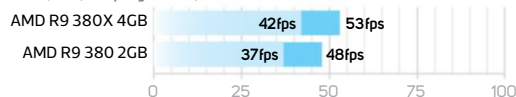


2,560 x 1,440, High detail, Nvidia HairWorks off

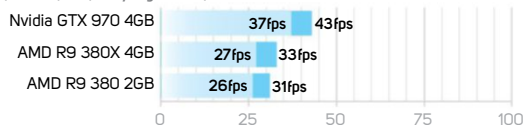


CRYSIS 3

1,920 x 1,080, Very High detail, 0x AA

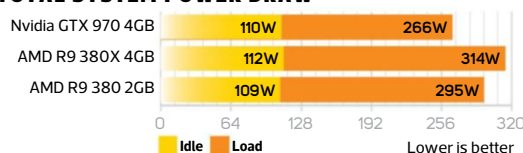


2,560 x 1,440, Very High detail, 0x AA



Stock speed min Stock speed avg Overclocked min Overclocked avg

TOTAL SYSTEM POWER DRAW



Lower is better

VERDICT

A solid sub-£200 offering from AMD with good bang per buck and no equivalent competitor from Nvidia.

MINI-ITX CASE

Fractal Core 500 / £40 inc VAT

SUPPLIER www.ebuyer.com / MODEL NUMBER FD-CA-CORE-500-BK

As you shrink cases down to sizes that cater exclusively for mini-ITX motherboards, the layout becomes far more critical than for larger cases. Including numerous drive bays often results in poor cooling and it's unusual for a small case to offer extensive room for large CPU coolers and graphics cards, yet still have enough flexibility to install hefty water-cooling radiators. However, Fractal Design's new Core 500 appears to have managed all the above in a case that costs, thanks to mainly steel and plastic construction, just £40 inc VAT.

Fractal Design has been tinkering with small cases since 2012, with the introduction of the Node 304. However, the Core 500 is a very different case, inside and out. The only similarity is that they're both flexible, small, cube-style

cases. For starters, the Core 500 sports an external 5.25in bay, plus it's a little smaller than the Node 304, while the front panel with two USB 3 ports has been relocated to the top.

The big changes have occurred on the inside. The Core 500 maintains the Node 304's ability to house large CPU coolers and graphics cards, but the CPU cooler height limit has increased with

We managed to fit a Corsair H100i radiator in the roof mount

the Core 500, to 170mm from 165mm. The latter was admittedly enough for many coolers such as SilverStone's excellent Argon AR01, but larger models would likely end up fouling the roof. The Core 500's extra clearance means that, whichever air cooler you want to use, it should fit.

Graphics cards up to 310mm in length are supported too, while modular PSUs have a length limit of 160mm, with captive models gaining an extra 10mm, as their cables don't need as much clearance.

Of course, air cooling isn't the Core 500's only trick. It offers excellent support for water cooling too, with the roof section able to accommodate even double 140mm-fan radiators. We managed to fit a Corsair H100i in the roof and still had access to the lower part of the front drive mount, although you'll lose the ability to install an optical drive in such a setup. There's 100mm of clearance in total if you remove the drive mount, which is easily achieved by popping off the front panel and getting shot of four screws. You'll then have enough room for 30mm and 45mm-thick radiators with two rows of fans, or a single full-height 60mm-thick radiator with a single row of fans. Sadly, Fractal claims there isn't enough space for radiators with attached pumps, though, so the likes of EKWB's Predator are unlikely to fit.



A single 140mm fan is included as default, located in the rear of the case, but there are plenty of ventilation holes, all of which sport dust filters, and the filters on the shell of the case are magnetic too. The aforementioned rear fan sits at the top of the case, so it's aligned with standard-sized, tower CPU coolers – small coolers may not be able to take full advantage of it. Meanwhile, your graphics card will be situated slap-bang next to a large vent in the case shell and, as we've seen in cases such as Corsair's Obsidian 250D, such a setup usually results in excellent cooling, although only double-slot graphics card coolers are supported.

There's enough space for plenty of drives too, with three dedicated 2.5in mounts – one accessible by removing the front panel, and the other two placed on a mount on the side of the case.

Behind this mount sit two 3.5in mounts, with space for a further 3.5in drive in the removable front drive mount. With the exception of the need to remove the latter, along with the drive mount, to install larger radiators, none of the drive mounts interferes with the water-cooling support – the ability to house three SSDs and three hard disks, yet still offer excellent air and water-cooling support, is quite a feat when working with such restricted dimensions.

Installing your hardware in the Core 500 is the only snag, as you're dealing with fairly cramped conditions. Removing the twin fan mount in the roof requires that you also detach the front drive mount, for example, as the two are linked together. There's also next to nowhere to hide cables – if

/SPECIFICATIONS

Dimensions (mm) 250 x 380 x 213 (W x D x H)

Material Steel, plastic

Available colours Black

Front panel Power, reset, 2x USB 3, stereo, mic

Drive bays 1 x 5.25in, 3 x 3.5in, 3 x 2.5in

Form factor(s) Mini-ITX

Cooling 2 x 120mm/140mm roof fan mounts (fans not included), 1 x 120/140mm rear fan mounts (1 x 140mm fan included)

CPU cooler clearance 170mm

Maximum graphics card length 310mm





1
The front panel with two USB 3 ports has been relocated to the top

2
There are plenty of ventilation holes, all of which sport dust filters

3
The roof section can even accommodate double 140mm-fan radiators

you don't use a radiator in the roof, the drive mount is one place to stash them, but that isn't an option if you use the 5.25in and 3.5in bays in that location. Installing a PSU is also a challenge, as the mount is located at the front of the case – we'd recommend attaching the power cables first, as it's hard to hook them up once the PSU is in place.

Performance

As we suspected, the graphics card mount being right up against the side panel resulted in some fantastic results for the GPU delta T. We measured it at 43°C, which is even better than the results from the Node 304 and Obsidian 250D. The CPU delta T was good too, although the Corsair Graphite 380T on its maximum fan speed was slightly cooler. Even so, the Core 500 beat the Obsidian 250D again and matched the Node 304. The included 140mm fan was

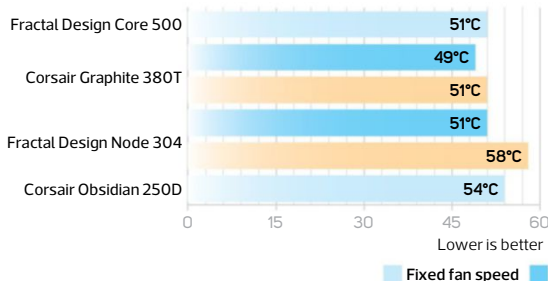
also very quiet indeed, although it lacks the speed control offered with the Node 304 and Graphite 380T.

Conclusion

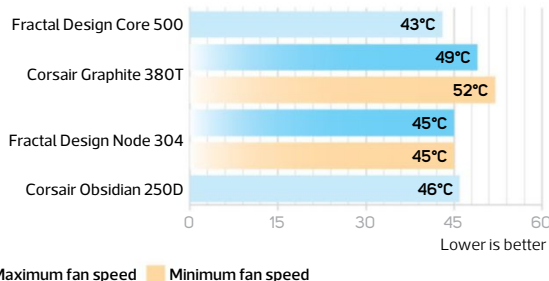
It's great to see a company fiddling with the stereotypical layout of cube-style mini-ITX cases, and the Core 500 really shakes up the market in this respect. It might not be quite as solid and well-made as the Obsidian 250D, and it's cramped inside, but otherwise, it matches the Corsair's abilities and offers more besides, in a smaller space, with support for larger radiators, space for more drives and a cheaper price of just £40 inc VAT. If you fancy building a mini-ITX rig with an overclocked CPU and decent graphics card, whether it's air or water-cooled, the Core 500 offers a capable and wallet-friendly way to do it.

ANTONY LEATHER

CPU LOAD DELTA T TEMPERATURE



GPU LOAD DELTA T TEMPERATURE



COOLING
26/30

DESIGN
26/30

FEATURES
17/20

VALUE
19/20

OVERALL SCORE
88%

VERDICT

The Core 500 is an excellent mini-ITX case for both air and water-cooled systems, offering great cooling in a tiny case that costs less than £50.

Performance without compromise



Spectre Lite

- AMD FX-4300
- ASUS® M5A97 R2.0
- 8GB Hyper-X FURY RAM
- 2GB NVIDIA® GeForce® GTX 950
- 1TB Hard Drive
- Corsair 350W Power Supply
- **Windows 10**
- 3 Years Standard Warranty

THIS SPEC FROM **£499***



Gladius 900

- Intel® Core™ i5-6600K
- ASUS® Maximus VIII Hero
- 8GB HyperX FURY RAM
- 2GB NVIDIA® GeForce® GTX 960
- 1TB Hard Drive
- Corsair 450W Power Supply
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MICRO-ATX MOTHERBOARD

Gigabyte Z170MX-Gaming 5 / £132 inc VAT

SUPPLIER www.ebuyer.com



While mini-ITX might be grabbing the headlines recently, there's a slightly less drastic way to get a smaller PC. The micro-ATX form factor allows for cases that are significantly smaller than ATX chassis, yet you still have the option of using sound cards, PCI-E SSDs or other expansion slot devices along with your graphics card, which simply isn't possible with mini-ITX motherboards. The Maximus VIII Gene from Asus is the micro-ATX king here, but the stunning-looking Gigabyte Z170MX-Gaming 5 costs a massive £40 less.

The Z170MX-Gaming 5 sports a similar colour scheme to Gigabyte's larger ATX Z170X-Gaming 3, but lacks the large white shrouds of the Gaming 5 and Gaming 7 ATX models.

However, it still sports the great-looking steel expansion slot shrouds, which match the chrome details of the heatsinks and the shiny CPU socket, attractively complementing the red and black details on the motherboard. There's a bright LED backlight around the audio circuitry too, which can pulse or beat in time to music – it looks feature-packed, edgy and very smart as a result.

There are three 16x PCI-E slots, which support both CrossFire and SLI, with the top two slots dropping to 8x mode in two-way setups. However, there's a potential issue using multi-GPU setups, which is that using two dual-slot cards leaves next to no space for the upper card's cooler to breathe. Such a setup may result in GPU throttling, especially if you're using two high-end AMD GPUs with reference coolers. Using waterblocks or third-party cards

with exotic coolers may solve the problem, but it's worth remembering this layout issue if you intend to build a small multi-GPU system, especially as the Maximus VIII Gene suffers from the same problem.

Another with issue using two dual-slot graphics cards is that doing so will mean you're unable to use any other devices requiring a PCI-E slot. While there's a 1x slot in addition to the three 16x slots, it's located below the primary 16x slot, so will be obscured completely by most graphics cards. You can, of

course, just use either of the secondary 16x slots for a sound card though. Thankfully, the M.2 slot is easily accessible, being located above the primary 16x slot and supporting up to 80mm SSDs.

The Z170MX-Gaming 5 also offers beefed-up audio circuitry with an isolated PCB, Nichicon capacitors, a DAC-Up low-noise USB port and a gain control switch for fine tuning. You can even change the included op-amp too. Gigabyte has also bundled Creative's SBX Pro Studio software, which works alongside the standard Realtek audio suite to bolt on features such as Creative's Crystalizer and EAX effects, as well as the ability to tweak bass redirection and crossover frequency.

One area the Maximus VIII Gene, and indeed the Z170MX-Gaming 5's larger siblings, have an advantage over this board, however, is when it comes to overclocking and testing tools. The Gene, for example, offers the full complement of an LED POST code display, the usual Asus ROG features such as USB BIOS flashback, and buttons for power, reset and clearing the CMOS.

The Z170MX-Gaming 5 lacks any buttons or LED displays, but then it does cost £40 less. Gigabyte hasn't cut back on too many other features though – you get both USB 3.1 Type-A and Type C ports powered by Intel's own Thunderbolt 3 controller (Thunderbolt can be used over the Type-C connector), plus three SATA Express connectors.

Performance

The claimed 104dBA SNR recording quality proved to be spot on with our own testing using RightMark's Audio Analyzer software, recording a noise level of -104.8dBA and a dynamic range of 105.2dBA. These results just pip most basic sound cards too; for example, Asus' Xonar DGX 5.1 managed -103dBA and 103dBA respectively. Storage

It still sports the great-looking steel expansion slot shrouds

/SPECIFICATIONS

Chipset Intel Z170

CPU socket Intel LGA1151

Memory support 4 slots: max 64GB DDR3 (up to 3466MHz)

Expansion slots Three 16x PCI-E 0, one 1x PCI-E

Sound Realtek ALC1150

Networking Killer E2201

Overclocking Base clock 80–500MHz, CPU multiplier 8–500x; max voltages, CPU 1.8V, RAM 2V

Ports 6 x SATA 6Gbps (Z170), 1x M.2, 1x USB 3.1 Type-A, 1x USB 3.1 Type-C, 3 x USB 3, 2 x USB 2, 1x LAN, 8-channel surround audio out, line in, mic, optical S/PDIF out, 1x HDMI 1.4, 1x DVI-D, 1x VGA, 1x PS2

Dimensions (mm) 244 x 244

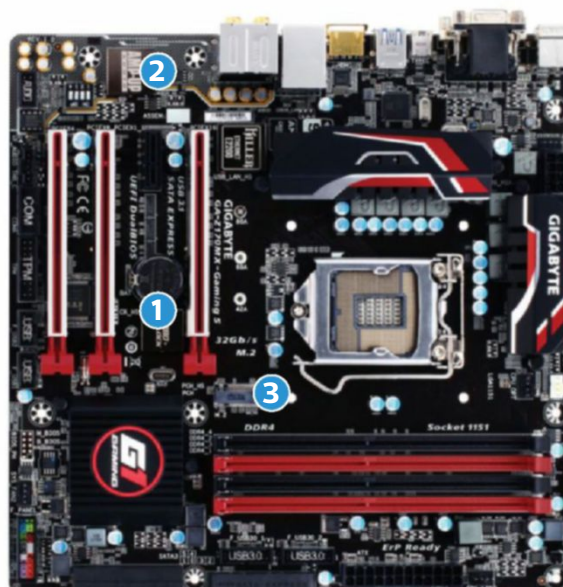


results were fine too – read and write speeds on the SATA 6Gbps ports of 563MB/sec and 529MB/sec were as expected and, when using Samsung's new 256GB 950 Pro M.2 SSD, we saw read and write speeds of 2,300MB/sec and 962MB/sec respectively.

We noticed a slight deficit at stock speed in the performance numbers, though, which seems to be down to the Z170MX-Gaming 5 not quite boosting our Core i7-6700K to its maximum 4.2GHz boost speed, according to CPU-Z. Instead, it hovered around 4GHz. We only apply the XMP profile in stock-speed tests, though, so it's worth remembering to give the target CPU ratio a boost in the EFI if you plan to run the Z170MX-Gaming 5 at stock speed. For example, the Gene managed a system score of 136,794 compared to 129,197 for the Z170MX-Gaming 5 – it isn't a deal breaker, but you may as well have the fastest performance possible.

Gigabyte's EFI is also relatively plain and simple compared with Asus and MSI's recent offerings, and isn't quite as clear as either. The voltage, memory and CPU settings are all in different sections and, while you can save up to eight overclocking profiles, there's no quick-access favourites section or fan control suite.

Most PC enthusiasts will just be concerned with the overclocking features, though, and it's easy to push this board to its limits once you know your way around. We settled with a 4.8GHz clock speed using a 1.43V vcore, 1.1V System Agent voltage and the loadline calibration on high. It isn't a bad result, but the Gene managed to add an extra 100MHz, putting it ahead in our benchmarks, and with lower power consumption too.



- 1 Filling the top two 16x PCI-E slots won't leave much room for dual-slot cards to breathe
- 2 The bright LED backlight around the audio circuitry can pulse in time to music
- 3 An M.2 slot is sensibly positioned above the top 16x PCI-E slot, and will accept up to 80mm SSDs

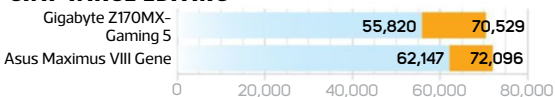
Conclusion

While the Z170MX-Gaming 5 didn't set our benchmarks alight, it's easy to overclock and has class-leading on-board audio. It looks great, sports most of the features you'd expect at this price and costs significantly less than Asus' Maximus VIII Gene. The Gene sports a considerable number of extra features, but if you just want to build a small PC, apply a decent overclock to your CPU and get on with some gaming, the Z170MX-Gaming 5 is an excellent choice. Just beware of using more than one air-cooled GPU.

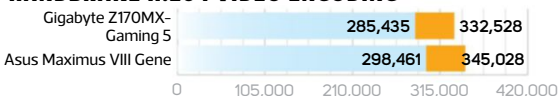
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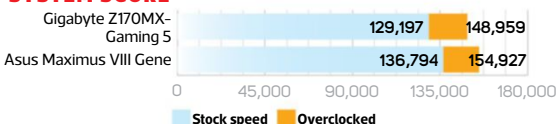
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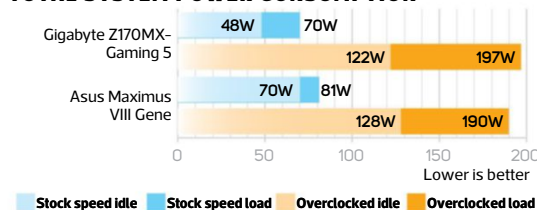
HEAVY MULTI-TASKING



SYSTEM SCORE



TOTAL SYSTEM POWER CONSUMPTION



TOTAL WAR: ATTILA

1,920 x 1,080, 0xAA, Quality setting



PERFORMANCE

25/30

FEATURES

25/35

VALUE
33/35

OVERALL SCORE

83%

VERDICT

The Z170MX-Gaming 5 isn't as feature-packed as the Maximus VIII Gene, but it's £40 cheaper, overclockable and looks great.

/TEST KIT

4GHz Intel Core i7-6700K, 16GB Corsair Vengeance LPX 2666MHz DDR4 memory, 256GB OCZ Arc 100 SSD, Corsair HX860i PSU, Windows 10 Home 64-bit

ATX MOTHERBOARD

MSI Z170A SLI Plus / £110 inc VAT

SUPPLIER www.cclonline.com

While Intel's top end Core i7-6700K is currently retailing for silly prices that even make a decent X99-based system good value for money, prices aren't too bad if you're not looking for a high-end motherboard and are happy with the Core i5-6600K. What's more, with recent news about simple BIOS updates now allowing non K-edition CPUs to be substantially overclocked using just the base clock (more on this next issue), budget Skylake builds are becoming a reality, which is where MSI's Z170A SLI Plus comes in.

At just £110 it's the joint cheapest Z170 motherboard we've reviewed, with the similarly priced ASRock Z170 Extreme4 picking up an Approved award in our last motherboard Labs test (see Issue 147, p41). At face value, there isn't a lot missing compared with more expensive boards either. You get an M.2 slot capable of handling up to 80mm SSDs, which is handily located above the primary 16x PCI-E slot for easy access, and there's also isolated audio circuitry and even a USB 3.1 Type-C port. Both boards have a trio of 16x PCI-E slots and 1x PCI-E slots too, with one of the latter located above the primary 16x slot, so you should always be able to use it.

However, there are a few missing features compared with the ASRock Extreme4. The latter managed to cram in the full complement of overclocking and testing tools – power, reset and clear-CMOS buttons, plus a POST code LED display. Like the MSI, the ASRock includes a USB Type-C port, but also a Type-A port, as well as four more USB 3 ports on the rear panel compared with the MSI board.

The Z170A SLI Plus does sport a black PCB and MSI's steel PCI-E slot covers, though, and as such, it looks great. However, the ASRock board isn't exactly bad-looking either. Both boards have six SATA 6Gbps ports and, while SATA Express is basically useless now, the ASRock board offers three SATA Express ports too. Thankfully, one area where the MSI definitely has the upper hand is the EFI. It's relatively easy to navigate through the Extreme4's EFI, but the MSI board's EFI is better laid out, clearer and has all the usual overclocking settings on a single page, whereas they're spread over three pages on the ASRock board.

Performance

One area where MSI has cut back is the audio circuitry. With a dynamic range of 96dBA, this board was some way behind the 103dBA recorded by the Extreme4. Meanwhile, in the speed tests, it was neck and neck for the most part, with barely 100 points separating the stock

speed system scores in our RealBench 2015 suite. The MSI board did consume less power than the ASRock though.

Thanks to the MSI's aforementioned excellent EFI, we had no trouble finding the limits of its overclocking prowess. Sadly, it wasn't quite as high as we'd hoped, though, hitting a wall at 4.7GHz with nothing we tried getting us any further. This overclock required 1.38V too, which is a little higher than the voltage required by many pricier boards to reach 4.8GHz.

Comparatively, the Extreme4 did manage to hit 4.8GHz, but only when we pumped a hefty 1.48V through the CPU, which isn't recommended with Skylake CPUs for long-term use, but it's enough to get some benchmarks.

With a 100MHz deficit in overclocked clock speed, the Z170A SLI Plus was a little off the pace in our benchmarks across the board, although its overall system score was only 2 per cent off the score of the ASRock Extreme4.

Conclusion

There's a lot to like about the MSI Z170A SLI Plus. It offers great value for money, has an edgy black PCB, an excellent EFI and overclocks reasonably well too. It's definitely a board for everyday modest overclocks though; you wouldn't want to push it to its limits on a regular basis. However, ASRock's Z170 Extreme4 pips it to the post in a number of areas, with more ports, overclocking tools, superior audio performance and slightly better overclocking abilities. As such, it's a better buy, unless you really want a black motherboard to match your PC's colour scheme.

ANTONY LEATHER



/SPECIFICATIONS

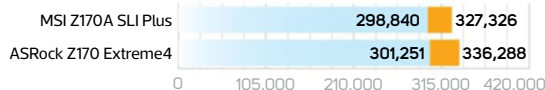
Chipset Intel Z170**CPU socket** Intel LGA1151**Memory support** 4 slots: max 64GB DDR3 (up to 3733MHz)**Expansion slots** Three 16x PCI-E 3, three 1x PCI-E 3**Sound** Realtek ALC1150**Networking** Intel Gigabit LAN**Overclocking** Base clock 98–341MHz, CPU multiplier 8–83x; max voltages, CPU 2.155V, RAM 2.2V**Ports** 6 x SATA 6Gbps (Z170), 1x M.2, 2x USB 3, 1x USB 3.1 Type-C, 2x USB 2, 1x LAN, 8-channel surround audio out, line in, mic, 1x HDMI 1.4, 1x DVI-D, 1x VGA, 2x PS2**Dimensions (mm)** 305 x 244

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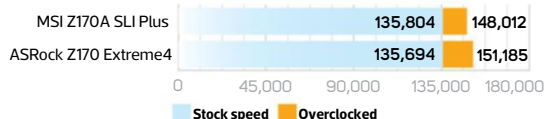
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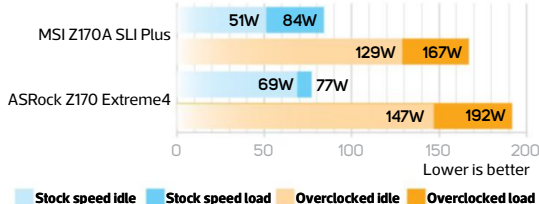
HEAVY MULTI-TASKING



SYSTEM SCORE



TOTAL SYSTEM POWER CONSUMPTION



TOTAL WAR: ATTILA

1,920 x 1,080, 0xAA, Quality setting



PERFORMANCE

26/30

FEATURES

24/35

VALUE
30/35

OVERALL SCORE

80%

VERDICT

A good value Skylake board with an excellent EFI, but it lacks too many features compared to the similarly priced ASRock Z170 Extreme4.

/TEST KIT

4GHz Intel Core i7-6700K, 16GB Corsair Vengeance LPX 2666MHz DDR4 memory, 256GB OCZ Arc 100 SSD, Corsair HX860i PSU, Windows 10 Home 64-bit



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GAMING MOUSE

Roccat Kova / £50 inc VAT

SUPPLIER www.cclonline.com

Unusually for an ambidextrous mouse, the Kova is comfortable to wield. While it lacks proper ring-finger and pinky support, it's otherwise well suited to a palm grip with a comfortably placed hump and no protruding edges where your hand rests. A claw grip is feasible too, although there are no high-grip rubber sides. That said, while the matt plastic is smooth and pleasant to rest against, it isn't too slippery either, so you won't lose control.

The build quality impresses too – the body is solid and the 1.8m braided USB cable is kept slightly elevated by its connection, reducing drag. There are also six thick PTFE feet for smooth movement on practically any surface.

Between the main clickers is a scroll wheel and resolution toggle. The wheel is securely mounted, sports a rubberised surface and has a lovely action when clicking and scrolling,

while the resolution toggle is big and light enough to hit with ease. There's also the standard pair of thumb buttons on both sides, and their placement feels natural.

Lastly, both the left and right clickers have an elevated button on their outer edges termed Smart Cast by Roccat. These buttons offer a fantastic way to add extra features – they're big and light, making them easy to hit in a hurry, but

they're also kept out of the way in normal use.

The Kova supports Roccat's EasyShift[+] function, which can be set to any key and, much like Shift, gives each button a secondary function while that key is held. This feature increases the total usable command set to 22, although more realistically, it's 18 because it isn't easy to access the side buttons opposite your thumb.

Then there's Roccat's sublime Swarm software, with which you can reprogram the 22 commands. The layout is great, feels instantly familiar and it's very fast too. Buttons are programmed using a dropdown menu, and pretty much all functions are available: hotkeys, timers, media keys, shortcuts to programs, resolution and profile control. You can also record and apply your own macros, but the software already includes a massive list of pre-programmed ones for modern games and applications such as Photoshop – a really good touch.

/SPECIFICATIONS

Connection Wired, USB
Sensor Optical
Resolution 3,500dpi
 native; 7,000dpi overdrive
Cable Braided
Material Plastic
Extras None



The wheel sports a rubberised surface and has a lovely action

Swarm is also used to control the two RGB lighting zones – the scroll wheel and the rear rim. The colours can be configured independently, although effects are applied to both areas together. Meanwhile, the mouse's 512KB of memory can store up to five on-board profiles, and the mouse also supports auto-switching based on opening a certain application or game.

Then there's the engine of the unit – a Pro-Optic R6 optical sensor with a native resolution of 3,500dpi, although up to 7,000dpi is supported via an overdrive mode. Purists will tell you to avoid such modes, but we found that the 72MHz Turbo Core V2 32-bit ARM based MCU did a good job of maintaining smooth tracking beyond the native resolution. That said, 3,500dpi is more than enough anyway. The sensor is also free from acceleration and prediction, and we found it to be very accurate and pleasant to use across its resolution spectrum.

Each profile can store up to five DPI stages, from 250 to 7,000dpi, in 50dpi increments. The Kova supports up to 1,000Hz polling for a 1ms response time as well, although this setting can be tweaked.

Conclusion

We're really impressed by the Kova. The excellent button layout coupled with EasyShift[+] provides heaps of customisation without resorting to an overcrowded thumb zone, for example. The intuitive and powerful software will keep even the most serious gamers happy, especially with the multiple on-board profiles. It also tracks accurately and is comfortable to hold, for both right and left-handed users. The price of £50 inc VAT isn't cheap, but given the design and feature set, it's fair if you're serious about customisation.

MATTHEW LAMBERT

DESIGN 37/40	FEATURES 31/35	VALUE 21/25
OVERALL SCORE		
89%		
VERDICT		
A really well-designed mouse that includes genuinely useful features and awesome software.		





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Paul Goodhead checks out the latest gadgets, gizmos and geek toys

BOARD GAME

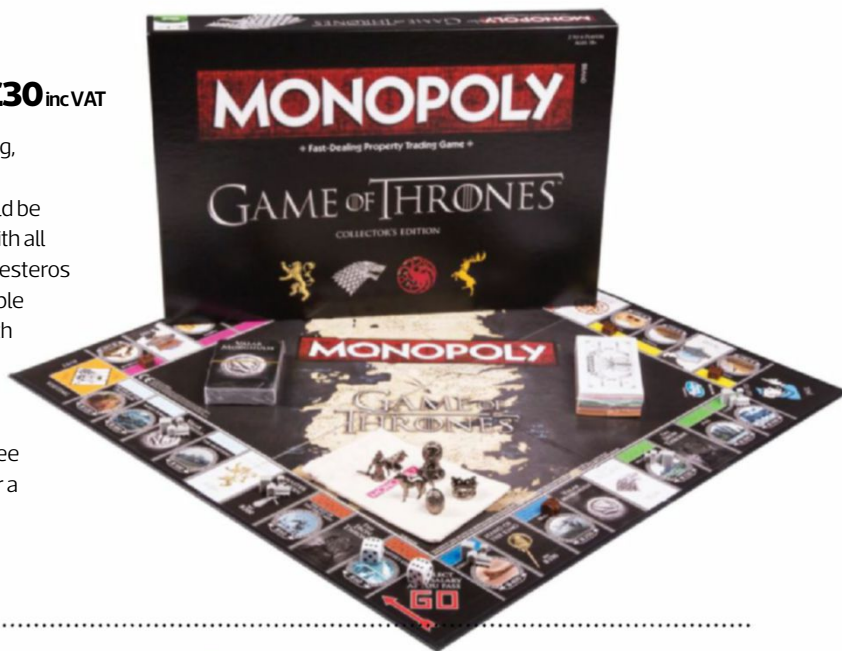
Game of Thrones Monopoly / £30 inc VAT

Few fantasy worlds seem as well matched to the family-breaking, argument machine that is Monopoly than the brutal, politically mercenary world of Game of Thrones. We can't help think it would be Littlefinger's game of choice, were he ever introduced to it. As with all Monopoly special editions, the board looks great. A full map of Westeros graces its centre, with beautiful artwork for each of the purchasable locations around the edge. The playing pieces are unique too, with iconic items such as dragon eggs replacing the usual pieces.

We can't help feeling a little disappointed that Hasbro hasn't reworked some of the other artwork, however – it would be even better to see custom images or ideas for the Go To Jail or Free Parking spaces, but either way, this game still makes a fun gift for a diehard Game of Thrones fan.



SUPPLIER www.firebox.com



PHONE ACCESSORY

Veho Muvi X-Lapse /

£20 inc VAT

With increasing numbers of smartphone and compact cameras sporting time-lapse modes, it isn't a surprise to see gadgets such as the Muvi X-Lapse pop up. In essence, it's an egg timer; you twist the unit to start it, and the upper portion then rotates for a while depending on how far you twisted it – a full 360-degree takes an hour to tick (audibly) down.

A large clip on the top allows you to mount a smartphone to the rotating base, but there's also a standard tripod mount on the bottom for compact cameras. Despite the device's simplicity, the results are great, lending time-lapse videos a greater sense of movement and interest than just a static shot. Serious photographers will want a more flexible device, but for casual snappers, the Muvi X-Lapse is a fun, well priced gadget.



SUPPLIER www.firebox.com



HOME ALARM SYSTEM

Myfox Home Alarm and Security Camera /

£249 inc VAT (Home Alarm); **£169** inc VAT (Security Camera)

While the Internet of Things may be an awfully titled concept, the potential for having everyday items such as the Myfox Home Alarm linked to the Internet is pretty exciting. The alarm can buzz your phone if it senses an intruder, and if you have the optional Security Camera, it will even send you a clip of said intruder. The alarm is operated by either a smartphone app or a key fob, each of which can be assigned a name. As a result, you're then able to see who has turned the alarm on or off – ideal for letting you know the kids have got home safe.

A few issues sour the experience, however. Firstly, despite costing £249 inc VAT, the alarm pack includes only one IntelliTAG door/window vibration sensor and remote, along with the alarm unit and the hub that links all the bits together. One isn't enough though – you're likely to need two or three of each to make the system work properly.

You can pick up more separately, but at £40 and £25 a unit respectively, the costs soon add up. At least the tags work well – they could tell the difference between a knock and a genuine attempt to force a door in our tests. The key fobs, on the other hand, which are meant to disarm the alarm when in proximity to it, were unreliable.

The optional camera is also a little short on features compared with rivals such as the Nest Cam, and Myfox charges an additional monthly fee to store the camera's footage in the cloud. The app, which ties all the parts together, is quite swish, but even so, both the Home Alarm and the Security Camera end up being overpriced for what you get.

ALARM ●●●●○

CAMERA ●●●●○

SUPPLIER www.getmyfox.com



EXTERNAL BATTERY

EnerPlex Jumpr Slate 5k / **£40** inc VAT

Being thin, long and wide, the Jumpr Slate is physically similar to the modern smartphones it's likely to charge – if your bag or coat has a phone pocket, the Slate will fit neatly into that pocket too. Available in micro-USB and Lightning variants, the sturdy, bright orange captive cable removes the need to remember a separate charging lead.

Thoughtfully, there's also still a standard USB socket, should you need to charge a gadget that's incompatible with the built-in cable. The Slate charged a Nexus 5X phone fully once, then to 23 per cent a second time around – a solid result for a 5,000mAh unit. Combine this performance with the stylish and practical design, and the £40 asking price is clearly reasonable too.

●●●●○

SUPPLIER www.maplin.com



BLUETOOTH SPEAKER

Creative Sound Blaster Roar /

£130 inc VAT

It may have taken an age for Creative to produce a Bluetooth speaker, but the Roar is a quality piece of kit, with more features than you can shake a fretboard at. Audio can be supplied via Bluetooth, 3.5mm jack, USB or from a microSD card. It can even record audio, and it also supports NFC and doubles as a battery to charge an ailing phone.

Three drivers and two passive radiators combine to create a deliciously full sound, with plenty of high-end punch and satisfying bass. If we were being picky, we'd say the bass can sometimes dominate a little, with mid-range detail losing out as a result, but it's a blemish that's easy to overlook on an otherwise great speaker.

●●●●○

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How we test

Thorough testing and research is the key to evaluating whether a product is worth buying, and deciding whether or not there's a better alternative

PROCESSORS

We judge CPUs on whether they offer sufficient speed for the price. Part of a CPU's speed score comes from how overclockable it is. Every type of CPU is tested in the same PC, so all results are directly comparable.

INTEL LGA1151



INTEL LGA2011-V3



AMD FM2+



COMMON COMPONENTS

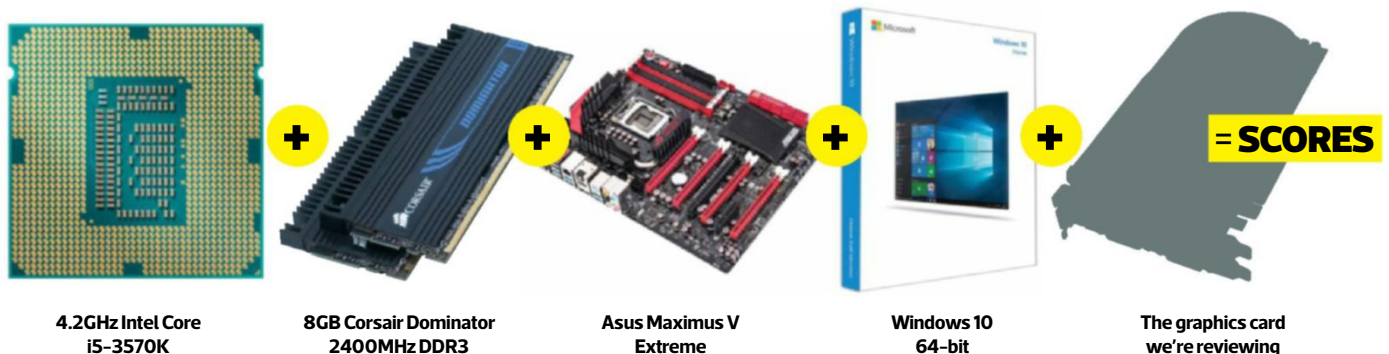


TESTS: We use Custom PC RealBench 2015, Cinebench R11.5 and a variety of games. We also test the power draw of the test PC with the CPU installed. These tests reveal a broad range of performance characteristics, from image editing to gaming and video encoding to 3D rendering. We run all tests at stock speed and again when overclocked to its highest frequency.

*Please note: We test AMD FM2+ APUs using the on-board graphics, not the Nvidia GeForce GTX 780 3GB

GRAPHICS CARDS

Graphics cards are mainly evaluated on how fast they are for their price. However, we also consider the efficacy and quietness of the cooler. Every graphics card is tested in the same PC, so all results are directly comparable.



CUSTOM PC REALBENCH 2015

INTEL REFERENCE



AMD REFERENCE

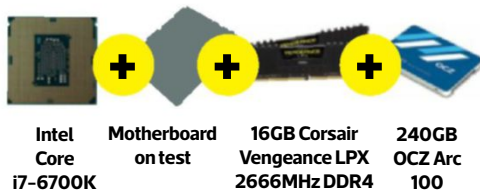


Our benchmark suite, co-developed with Asus, simulates how people really use PCs – a higher score is better. You can download them from www.asus.com/campaign/Realbench

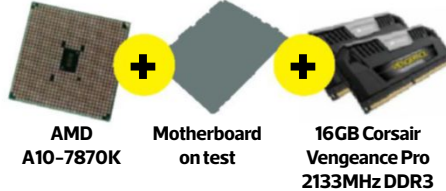
MOTHERBOARDS

Motherboards are evaluated on everything from layout and features to overclockability and value for money. Every motherboard is tested with the same components, so all results are directly comparable.

INTEL LGA1151



AMD FM2+



INTEL LGA2011-V3



COMMON COMPONENTS



TESTS: We use Custom PC RealBench 2015 and Total War: Attila, and also test the speeds of the board's SATA and M.2 ports. We try to overclock every motherboard we review by testing for a maximum QPI, base clock or HTT as well as overclocking the CPU to its maximum air-cooled level. We run our tests at stock speed and with the CPU overclocked.

*Please note: We test AMD FM2+ motherboards using the on-board graphics, not the AMD Radeon R9 390X

The Awards



EXTREME ULTRA

Some products are gloriously over the top. These items of excellent overclock earn our Extreme Ultra award.



PREMIUM GRADE

Premium Grade products are utterly desirable – we'd eat nothing but beans until we could afford them.



PROFESSIONAL

Products worthy of the Professional award make you and your business appear even more awesome.



APPROVED

Approved products are those that do a great job for the money; they're the canny purchase for a great PC.



CUSTOM KIT

For those gadgets and gizmos that really impress us, or that we can't live without, there's the Custom Kit award.



TESTS: By using the fast PC detailed on the left, we can be sure that any limitations are due to the graphics card on test, rather than being CPU limited. We test GTA V, Shadow of Mordor, Crysis 3, Fallout 4 and The Witcher 3: Wild Hunt at their maximum detail settings, in their highest DirectX mode, at several resolutions. High-end cards should be able to sustain playable frame rates at 2,560 x 1,440, while 1,920 x 1,080 is more important for mid-range cards; we also test at 3,840 x 2,160 for 4K monitors, and try to overclock every graphics card we test to assess the performance impact.



LABS TEST

Cards on the table

AMD's Radeon R9 380 and Nvidia's GeForce GTX 970 were favourites in our last GP Labs test, so this month we've tested several cards based on each GPU to find the best ones for your needs

In our most recent graphics card labs test (see Issue 148, p40), **Custom PC** cast its watchful eye over the entire GPU market. We found that Nvidia's GeForce GTX 970 hit the sweet spot in terms of bang per buck, especially for 2,560 x 1,440 gaming, while AMD's Radeon R9 380 offered the best balance of performance and value in the sub-£200 category, offering great speed at 1080p and even some 2,560 x 1,440 gaming abilities.

There are loads of cards available with these GPUs, though, with various manufacturers offering different clock speeds, coolers, display outputs, accessories and pricing, and even different PCB sizes. For this reason, we're going to examine the differences between various third-party GTX 970 and R9 380 cards, so you can find the best GTX 970 or R9 380 card for your needs.

MATTHEW LAMBERT AND ORESTIS BASTOUNIS

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How we test

All our graphics tests are performed on an Asus Maximus V Extreme LGA1155 motherboard with an Intel Core i5-3570K running at 4.2GHz. Alongside these parts are 8GB (2 x 4GB) of Corsair Dominator 2400MHz DDR3 RAM and a 480GB SanDisk Extreme Pro SSD. Power comes from a LEPA G1600 PSU and the system runs Windows 10 64-bit.

While our regular GPU Labs tests are focused on finding the best-value GPU for attaining playable frame rates at a given resolution, assessing the best third-party card shifts the focus to other factors such as features, overclocking potential, noise and thermals. After all, that's where the differences will lie – if you're buying an R9 380 or GTX 970, you already know roughly what performance you're getting. A higher factory overclock is certainly good, but a few extra frames per second shouldn't be the only factor in your purchase decision.

Even so, the first order of business is assessing out-of-the-box performance. We run three of our regular benchmarks – Shadow of Mordor, The Witcher 3 and our new Fallout 4 test (see p90) – at both 1080p and 2,560 x 1,440. Our Fallout 4 test uses a 30-second manual play-through at Ultra settings with TAA enabled. Our Shadow of Mordor test, meanwhile, is a 35-second recording of the game's built-in benchmark at the game's Ultra preset. Lastly, The Witcher 3 is tested using a 45-second manual play-through at the game's High graphics preset, with Nvidia HairWorks disabled. All tests are recorded using Fraps and each one is repeated three times for consistency. Using these results, we calculate a performance score that accounts for 25 per cent of the overall score. For R9 380 cards, we give a higher weighting to 1080p performance, while for GTX 970 cards, 1080p and 2,560 x 1,440 performance count equally towards the performance score.

We get results for power consumption and thermals by looping Unigine Valley 1 for 15 minutes, recording the peak system power consumption from the mains and taking a temperature reading with GPU-Z. We then let the system stay idle at the Windows desktop for five minutes before taking idle readings. All temperature results



We record the most demanding parts of the built-in benchmark for Shadow of Mordor

are presented as delta T figures – the difference between the recorded result and the ambient temperature, and all cards are tested in a closed ATX case to mimic a real-world setup.

Due to uncontrollable, varying levels of background noise in our lab, we're unable to take accurate noise measurements. Instead, we rely on our ears and comment on noise levels in each review if they're noticeably loud or quiet.

We then overclock both the core and memory of each card, adding voltage only if possible and necessary. To test the impact, we re-run our Fallout 4 and load power consumption benchmarks.

Power consumption, thermal performance, noise and overclocking are all incorporated into the Design and Features score, which accounts for 45 per cent of the total score. This score also takes the size of each card (length, height and number of expansion slots occupied) into account, where smaller is considered better. Other

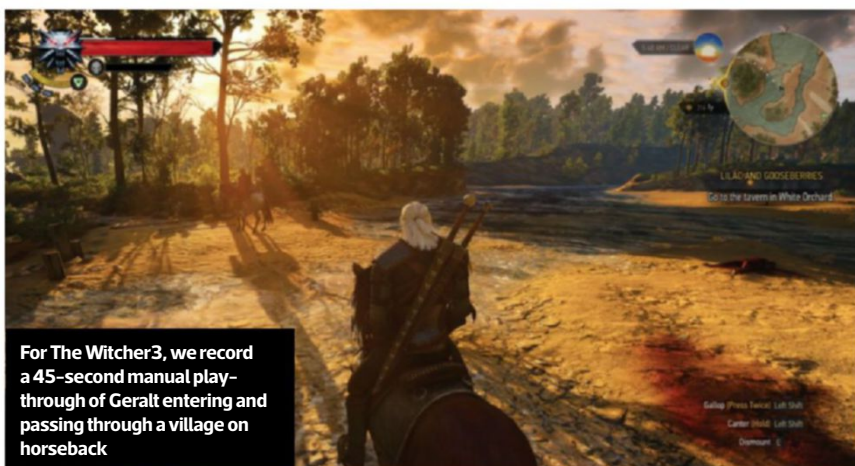


Our Fallout 4 test uses a 30-second manual play-through at Ultra settings with TAA enabled

features for which we award points are the card's display outputs, as well as specific features, such as whether it has a PCB backplate, a semi-passive cooling system or a dual BIOS switch, for example.

The last aspect of the overall score is Value, which accounts for the final 30 per cent and is calculated by dividing the other two scores by the price.

Note that the R9 380 scores are relative only to the other R9 380 cards, and the same applies to the GTX 970 cards – you can only compare scores for cards using the same GPU.



For The Witcher 3, we record a 45-second manual play-through of Geralt entering and passing through a village on horseback

Asus GTX 970 DirectCU Mini / £255 inc VAT

SUPPLIER www.cclonline.com

The most powerful and capable card for a mini-ITX PC is currently the AMD R9 Fury Nano, which squeezes a beefy GPU and HBM memory onto a tiny PCB. However, it can also throttle at high temperatures and, with Nano prices currently hovering around £500, you currently get a better balance of performance and value from a cheaper short-PCB card. One option is Sapphire's R9 380 ITX Compact OC (see p50), but for an extra £100 you can also get the Asus GTX 970 DirectCU Mini.

It's a dual-slot card that measures 171mm long and 121mm high, making it small enough to mount in a compact case, and with a bit of breathing space too. The size only gives it enough space for an active cooler with a single fan, though, so Asus has been reserved with its overclock, increasing the GPU base clock by 38MHz to 1088MHz, or 3.6 per cent, with a 1228MHz boost clock, while the memory is left at stock speeds.

The package doesn't have many extras either – there are no additional accessories, and no dual BIOS, although there's a backplate built onto the card. Meanwhile, video outputs are the typical affair – there's dual-link DVI-I and DVI-D, plus HDMI and DisplayPort. At default clock speeds, the load power consumption is reasonably modest too, with our test system consuming 285W, partly explained by the modest clock speeds.

Idle temperatures are exceptionally low too, with a delta T of just 6°C, although this figure leaps up to 47°C under load, making it the second hottest GTX 970 card on test, although it's still cooler than the 54°C from the aforementioned Sapphire card. Noise



You don't lose much in the way of performance over a full-sized card

output is bearable, but other cards on test are noticeably quieter – the fan spins at 1,993rpm at the default Medium profile, which is faster than the full-sized GTX 970 Strix, but still slower than the KFA² Infin8 Black Edition.

You don't lose much in the way of performance by opting for the GTX 970 DirectCU Mini over a full-sized card though. At stock speeds, while it's the weakest GTX 970 card on test, it's only 1-2fps behind the OCUK GTX 970 NV Cooler. The difference is more noticeable when it's compared with the Inno3D and KFA², but we're generally talking about a difference of around 5fps. It's not the fastest card on test, but it's still clearly no slouch, despite its smaller size.

Our manual overclock yielded some good results too, and without needing added voltage. We brought the memory to 7.6GHz (effective) and the core GPU clock to 1289MHz. At these speeds, the DirectCU Mini's minimum frame rate made gains of 5-7fps in Fallout 4, although its results are still generally lower than the alternative GTX 970 cards. It gives the OCUK a run for its money

though, either equalling performance or coming in just slightly under it. If you consider the single fan and smaller PCB size, it's an impressive achievement from Asus.

Conclusion

Asus has done a good job of squeezing the performance of a full-sized GTX 970 into a small format. It isn't the fastest GTX 970 around, but its clock frequencies are still better than stock speeds.

Of course, this card isn't for power users who care about frame rates above all else and, in a full-sized case, we'd go for a larger, quieter model, such as Asus' own GTX 970 Strix.

However, if you're looking for a powerful graphics card with a short PCB, the Asus GTX 970 DirectCU Mini offers a good trade-off between speed, size and value for money.

VERDICT

Other GTX 970 cards are a little more powerful, quieter and cooler, but the DirectCU Mini is still a decent card if small size is your priority.

DESIGN & FEATURES		OVERALL SCORE
37/45		
PERFORMANCE	VALUE	84%
21/25	26/30	





Asus GTX 970 Strix / £260 inc VAT

SUPPLIER www.amazon.co.uk

As with the Asus R9 380 Strix (see p48), the Asus GTX 970 Strix's dimensions are slightly longer and taller than standard GTX 970 cards, measuring 280mm long and 141mm high. Asus has made good use of this space, though, fitting a beefy semi-passive cooler, and applying a decent overclock to the card.

As with the other Asus cards on test, there are no adaptors or extra cables in the box, but there are some goodies on the card itself. There's a backplate, and there's also an LED next to the PCI-E power connector to tell you when you've made a secure connection. The only notable feature lacking, when compared to the competition, is a dual BIOS.

Like the Asus R9 380 Strix, Asus has taken advantage of its extra cooling headroom by prioritising quiet operation over applying a huge overclock. The default overclock is relatively modest, adding 64MHz, or 6 per cent, to the stock core speed, taking it to 1214MHz. As with most of the other GTX 970 cards on test, the memory also remains at its default 7GHz (effective) clock speed. While the overclocks aren't massive, though, the Strix is the

quietest GTX 970 card on test, with the with the default 'Silent' fan profile spinning the fan at just 750rpm. The temperatures are fine too, with idle and load delta T results of 12°C and 41°C respectively.

Load power consumption is also the lowest of any GTX 970 card on test, at just 279W; 13 per cent less than the biggest gas guzzler, the KFA² GTX 970 Infin8 Black.

At its default speeds, the GTX 970 Strix delivers solid if not earth-shattering frame rates. It outperforms its ITX sibling and the OCUK GTX 970 by 1-2fps in all the Fallout 4 and Shadow of Mordor tests, with a similar gap in the Witcher III. The Inno3D, KF² and MSI cards all perform significantly faster though.

We then turned our attention to manual overclocking, raising the base GPU clock to 1334MHz, a 220MHz increase over stock clock speeds, and its memory to 7.5GHz (effective), and these settings didn't require any extra voltage either.

With this overclock applied, the performance in Fallout 4 improved considerably, adding 7fps to the minimum at 1080p, and 4fps at 2,560 x 1,440. Compared with the other cards when overclocked, however its position remains

roughly the same, being ahead of both the DirectCU Mini and OCUK cards, but again behind the Inno3D, KFA² and MSI cards. That isn't surprising, given that the Strix isn't just about performance, but also efficient cooling, low noise output and power consumption and, as always, it must be stressed that these performance differences are also slim.

Conclusion

The Asus GTX 970 Strix isn't the fastest GTX 970 card on test, but it's still faster than a reference card and, more importantly, it has a superb cooler that's practically inaudible in operation, but also doesn't get too hot. If your main priority is performance, then the KFA² Infin8 Black Edition is a fair bit quicker, but the Asus GTX 970 Strix strikes the best balance of performance, noise and thermals, and for a reasonable price too.

VERDICT

An exceptionally quiet card that's also a good performer, even if it isn't the fastest card on test. A great all-round card.

DESIGN & FEATURES

43/45

PERFORMANCE
22/25

VALUE
28/30

OVERALL SCORE

93%





Inno3D GTX 970 iChill Black 4GB / £320 inc VAT

SUPPLIER www.overclockers.co.uk

Inno3D's iChill Black Edition carries a significant premium over the alternative GeForce GTX 970 cards on test, thanks to its all-in-one liquid cooler. Although the card isn't particularly long, measuring 268mm long and 125mm high, the 120mm radiator takes up additional internal space in your case. It needs a spare 120mm fan mount for the radiator, a spare Molex plug and you'll need space for the extra tubing inside your PC case as well. The practicalities alone mean that not everyone will be able to accommodate this card.

But they'd be missing out on the most overclockable GeForce GTX 970 card we've tested. What's more, its default 1228MHz GPU base clock is higher than that of any other card on test, with a massive 16.9 per cent boost over the stock 1050MHz speed, and a measured boost clock frequency of 1562MHz. Inno3D is also the only company in this test that's dared to ship its GTX 970 with a memory overclock, with its GDDR5 memory running at 7.3GHz (effective), compared to the 7GHz stock speed.

This card looks good too. The 'iChill' cooler is an angular affair with a large backplate and an LED that glows depending on the GPU load, with blue for idle, green for low power and red for heavy loads. Inno3D has also upgraded the

video outputs from the stock GTX 970, giving you three DisplayPort outputs, HDMI 2 and only a single dual-link DVI-I connector – a far more useful selection for modern displays and TVs. A free mousepad is included in the box too, although it's hardly an essential, along with a DVI-to-VGA adaptor and a dual Molex to 6-pin PCI-E adaptor.

The cooler isn't quiet though. Even when idle, there's some apparent noise from the pump and, despite liquid-cooling power, its idle GPU delta T of 9°C isn't the lowest on test either. Load power consumption is slightly higher too at 304W, although that's explained by the higher core clock speed.

Interestingly, despite the high clocks, the Inno3D's performance at default speeds is slightly lower than that of the KFA² GTX 970 Infin8 Black (see p42), particularly in *Shadows of Mordor* and *The Witcher 3* at 1080p, where 3fps separates the cards' minimum frame rates. This difference is also evident in both *Fallout 4*, although not quite as pronounced.

The liquid cooler really excels when it comes to manual overclocking. With the help of an 87mV voltage boost, we took the Inno3D's GPU base clock all the way to 1398MHz, a huge 33 per cent increase over stock speeds, and we took the memory up to 8.3GHz (effective) too. At these settings, it

delivered the best frame rates in *Fallout 4* of any GTX 970 on test, with a minimum of 37fps at 2,560 x 1,440, and 60fps at 1080p. There's a surprisingly small performance gap between the Inno3D and the other cards on test when overclocked though – both the KFA² and MSI cards come close, and without the need for a liquid cooler too.

Conclusion

Although the Inno3D iChill Black outperforms all the other cards when overclocked, it isn't the fastest at default speeds, and the cooler adds some extra noise, as well as requiring installation of the radiator. This card is great for power users who value performance and overclocking potential over all other factors, but for everyone else, the cheaper Asus GTX 970 Strix is much quieter, while the KFA² GTX 970 offers very similar performance for a much cheaper price.

VERDICT

The fastest overclocked performance on test, but the cooler is an added hassle when cheaper alternatives still offer good performance.

DESIGN & FEATURES

39/45

PERFORMANCE
23/25

VALUE
22/30

OVERALL SCORE

84%





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KFA² Infin8 Black Edition / £260 inc VAT

SUPPLIER www.overclockers.co.uk

Being the cheapest full-sized card on test, you might expect the KFA² Infin8 to be the slowest performer, but the exact opposite is true. We were most impressed to see this card topping the performance charts in all three of our tests, despite its comparatively low price.

It sports a great-looking all-black design, which extends to the included backplate. There's no dual BIOS feature, but you do get a few adaptors in the box, including a pair of Molex to 6-pin PCI-E converters, plus two Molex to 8-pin PCI-E converters, along with a DVI-to-VGA adaptor.

The cooler is set to the highest default fan profile of any GTX 970 on test, though, at 2,200rpm, making it the noisiest full-sized card on test, although the noise from the cooler isn't bad – the other cards on test are quieter, but the KFA²'s cooler isn't loud either. The high-speed fan also results in the lowest temperatures of any GTX 970 card on test. At idle, the GPU delta T was just 5°C, and it only went up to 36°C at load. The latter result even matches the Inno3D card, which has an all-in-one liquid cooler, which is a great result from an air cooler. It's also a full 19°C cooler than the reference OCUK GTX 970 Nvidia Cooler's load result.

In its out-of-the-box state, the KFA² Infin8 Black Edition also has

the highest default clock speeds of any air-cooled card on test, with its GPU base clock of 1178MHz, second only to Inno3D's liquid-cooled monster, albeit with the same 7GHz (effective) memory frequency of the other air-cooled GTX 970 cards.

These clock speeds resulted in great gaming performance. In all three of our test games, the KFA² managed to produce the best minimum and average frame rates on test, at both 1080p and 2,560 x 1,440, even beating Inno3D's GTX 970 iChill Black. The difference was most pronounced in Fallout 4, where 6fps separated the KFA²'s minimum frame rate from that of the slowest card on test, the Asus DirectCU Mini.

Unfortunately, we couldn't push that already high GPU base clock much higher.

We could only add another 70MHz to it, bringing it to 1248MHz, although we were able to bump the memory frequency from 7GHz to 8GHz (effective).

This overclock resulted in performance increases that weren't as impressive as those of other cards once we'd overclocked them. There was only a 3fps gain in Fallout 4's minimum frame rate at 2,560 x 1,440, for example. But then the KFA² already had a head start over the other cards, and only the liquid-cooled Inno3D card was able to beat its performance when overclocked.

The one downer of these frequencies, of course, is power consumption, with our system drawing a whopping 322W from the mains with the card at its default frequency, and 338W once it was overclocked.

Conclusion

The KFA² Infin8 Black Edition takes the opposite approach to that of the Asus Strix. While that card shies away from wild default clock speeds in favour of efficiency and quiet operation, this card destroys all in its path, with the best frame rates of any GTX 970 on test, but at the cost of power consumption. It's also relatively noisy, but its cooler is very powerful, with some incredibly low temperatures at both idle and load. What's more, it's great value for money. The balance of noise, performance and power consumption makes the Asus Strix our overall card of choice in this test, but there isn't much in it. If performance is your top priority then this KFA² card is seriously powerful for the money.

VERDICT

The best out-of-the-box performance on test, and for a great price.

DESIGN & FEATURES

40/45

PERFORMANCE
24/25

VALUE
28/30

OVERALL SCORE

92%





MSI GTX 970 Gaming 4G / £266 inc VAT

SUPPLIER www.ebuyer.com

The modern PC hardware market is wonderfully diverse, thanks to firms catering for any segment they can imagine, making slight modifications to configurations to better suit different people's needs. For example, MSI has nine different versions of the GeForce GTX 970, each differing in slight ways, adjusting the cooler, clock speeds and PCB size to fit the needs and price points of different users. The GTX 970 Gaming 4G is one of the more high-performance models, behind cards such as the Golden Edition version, which has higher clock speeds.

Decked out in the trademark red and black MSI colours, it's a very big card, measuring 279mm long and 139mm high, making it almost the same length as the biggest card on test, the Asus GTX 970 Strix. The GPU base clock speed is set at 1114MHz, a boost of 64MHz, with no memory overclock applied.

There's no backplate or dual BIOS, and all you get in the box is a single 6-pin to 8-pin PCI-E adaptor. MSI has also stuck with the now-standard combination of video outputs, with dual-link DVI-I and DVI-D, HDMI and DisplayPort connections.

The cooler is at least semi-passive and very quiet. By default, the fan spins at 1,150rpm, making it

the second slowest fan on test and resulting in very low noise output. It cools the card reasonably well, with the idle GPU delta T sitting at 12°C, although the load delta T rises to 43°C, which is a good 12°C cooler than the OCUK Nvidia Cooler Edition, but still warmer than three competing cards on test.

The card itself isn't particularly power-efficient either. Our test rig sucked up 313W at load with the MSI card at its default clock speeds, considerably more than every card on test except the KFA² Infin8 Black.

The slight clock speed boost resulted in reasonable performance though. All its Fallout 4 frame rates at 1080p and 2,560 x 1,440 beat the two Asus cards on test, and the reference OCUK Nvidia Cooler Edition card, but it couldn't catch the Inno3D or KFA² cards. In Shadow of Mordor, the MSI also moved into second place in the stack of cards on test this month, and it was the second fastest on test in The Witcher III at 2,560 x 1,440 as well.

We were also pleased to see some excellent overclocking headroom, and we were able to apply fairly hefty boosts to both the GPU and memory clocks, without any extra voltage required. We took the GPU base clock all the way to 1294MHz, with the memory running at 8.2GHz (effective). These tweaks added an extra 7fps to the

Fallout 4 minimum frame rate at 1080p, and 5fps at 2,560 x 1,440, which is worth having. It isn't a bad show, although the overclocked power consumption of 339W at load raises a few eyebrows. While the MSI GTX 970 Gaming 4G is fast, cool and quiet, it consumes a fair bit of power too.

Conclusion

MSI has done well with the GTX 970 Gaming 4G, which offers very good performance figures and low noise output. Our sample had plenty of overclocking headroom too, but power consumption is a tad high. It's relatively good value for money too. Its only problem is that it's up against some very stiff competition at this price, with the cheaper Asus Strix coming with a backplate and being very slightly cheaper, cooler and more power-frugal, although the margins are very slim. If you can find the MSI card cheaper anywhere, it's definitely worth considering.

VERDICT

Fast and quiet, with good overclocking potential, but it's up against very strong competition.

DESIGN & FEATURES

40/45

PERFORMANCE
23/25

VALUE
26/30

OVERALL SCORE

89%





OCUK Nvidia 970 Cooler Edition / £290 inc VAT

SUPPLIER www.overclockers.co.uk

The OCUK Nvidia 970 Cooler Edition is a fancy name for what's essentially a stock-clocked GTX 970 with a reference cooler, with OCUK's in-house graphics card expert, Gibbo, putting the design together using genuine Nvidia components – the idea is that you get the fancy reference cooler from Nvidia's high-end GPUs, but on a GTX 970. Since Nvidia never released a reference PCB of its own into retail, it can now be tricky to hunt down a reference card, with most vendors only selling overclocked and modified GTX 970 cards.

It's a beauty though. The cooler looks very slick, with a simple green LED Nvidia logo on the top. It's quite big, measuring 268mm long, but not too tall, being just 110mm high. The cooler is quite bulky, though, and OCUK's extra work on this card bumps up the price, making it pricier than several of the other cards on test.

You're not paying for better performance either. It runs at stock speeds, so that means you get a 1050MHz core and 7GHz (effective) memory clocks. You don't get a dual BIOS either, and that cooler is in no way semi-passive, but there's a backplate and a few simple adaptors in the box. There are two dual-Molex to 6-pin PCI-E converters and a DVI-to-VGA adaptor as well. The

video outputs are a good configuration too, with three DisplayPort connectors, plus Dual-link DVI-I and HDMI.

The cooler isn't the quietest on test either, with a default fan profile of 1,850rpm – it's still quiet, but the MSI and Asus cards are definitely quieter. In terms of thermal performance, the cooler works well at idle, with the GPU delta T sitting at 11°C, but this figure shoots up to 55°C under load, which is considerably hotter than any other full-sized GTX 970 card on test. On the plus side, the reference cooler design means a fair amount of this hot air will be exhausted out of the back of the case. Power consumption is notably low as well, with our test PC consuming just 280W under load with this card installed.

As expected from the reference clock speeds, performance is slightly lacking. An average frame rate of 60fps in Fallout 4 at 1080p and 42fps at 2,560 x 1,440 places it well behind the MSI, KFA² and Inno3D cards, and 1fps behind the Asus GTX 970 Strix. It's at the bottom of the pile in Shadow of Mordor too, with the minimum frame rate of 39fps at 2,560 x 1,440 being a full 6fps slower than the KFA² GTX 970.

Surprisingly, though, we managed to push it quite far during overclocking, reaching a GPU base clock of 1294MHz, a 230MHz

increase, and an effective memory clock of 7.8GHz. Impressively, though, our test system's power consumption at load was only 291W at these settings, just 11W more than the already low 280W it draws at the default frequencies.

However, at these overclocked frequencies, Fallout 4 didn't hit the same high frame rates as those of some of the other cards on test, with minimums of just 56fps and 34fps at 1080p and 2,560 x 1,440 respectively.

Conclusion

The power-frugal OCUK Nvidia 970 Cooler Edition looks really good, and it's also the closest you're going to get to a GTX 970 card with a reference spec and cooler – it will look great in your PC, if that's your priority. That's a niche market, though, when cheaper cards perform better, and it isn't the quietest or best overclocker on test either. Unless you really want that reference Nvidia cooler, we'd opt for the Asus or KFA² cards instead.

VERDICT

A power-frugal and great-looking card but, unless you're desperate for the cooler, cheaper cards are both faster and quieter.

DESIGN & FEATURES

37/45

PERFORMANCE
21/25

VALUE
22/30

OVERALL SCORE

80%



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AMD Radeon software

AMD has recently retired its Catalyst Control Center (CCC) driver software, replacing it with a richer graphics application called Radeon Software, aiming to add features and refine the interface.

Speed improvements are one of AMD's biggest claims, promising quicker installation and launch times with the new software, although the scale of the speed boost depends on your CPU and graphics card. AMD quotes a rough improvement in installation time and load times of between 2x and 4.84x when using an Intel CPU, and 24x when using an AMD CPU.

In use, one area where we immediately noticed a speed-up is the number of clicks required to install it. The process feels more streamlined, with less messing about to get the software onto your system. Also, launching Radeon Settings with a right click is noticeably quicker than with CCC.

Another quoted area of improvement is power consumption, where AMD's hardware is significantly behind the green team. AMD claims an approximate 25 per cent drop in power use when viewing 1080p video with the new software, although no gaming power consumption figures have been quoted.

A feature called Frame Rate Target Control (introduced in the Catalyst 15.7 drivers) imposes a maximum frame rate for full-screen games, limiting power consumption that way. It's one sure-fire method of lowering power consumption and heat output, since any extra frames beyond 60fps are wasted on a 60Hz display, although we now live in era of 144Hz displays and beyond, where this feature becomes less useful.

The interface

We're generally very happy with the new interface in Radeon Software, which replaces the previous menu system with tiles and radio buttons to enable and disable settings. It's intuitive, fast and snappy. One of Nvidia's focuses in its GeForce Experience software is per-game graphics settings, which AMD has also addressed in a section called Game Manager. Installed games are automatically detected, and you get customisable profiles for each of them, along with a global profile that can adjust all game settings with just a few mouse clicks.



The core clock speed is now no longer represented as an absolute megahertz value, but as a percentage in the Overdrive settings



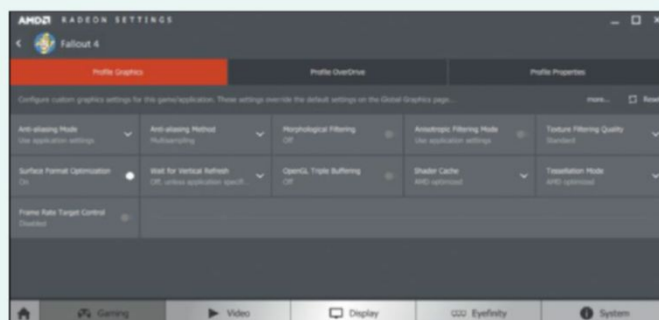
There are additional menu tabs for Video, Display, Eyefinity and System settings too. All the settings are much easier to find and tweak than with CCC and the layout is hugely improved. Also, if your GPU hardware doesn't support a feature, the settings for that feature are hidden.

Nvidia and AMD differ in their approach to driver-level GPU overclocking though. With Nvidia's GeForce Experience software, you have to rely on a third-party application to adjust the clock speeds or voltages of your GPU, but AMD has traditionally had an Overdrive feature in Catalyst Control Center that lets you set clock speeds manually. This feature is still present in the new Radeon Software suite, and now with per-game overclocking available in addition to the usual global settings.

The main Overdrive settings have changed, however. It gives you control of fan speed, power limit, core clock and memory clock speed, although memory overclocking is disabled on HBM-based cards (the Radeon Fury, Fury X and Nano). The core clock is now no longer represented as an absolute megahertz value, but as a percentage, although we (and we expect many other overclockers), would prefer both representations to be available – we wouldn't be surprised if this changes in the future.

It isn't all plain sailing with AMD's new Radeon Software suite though. In use, we ran into a small glitch where the v-sync setting for Fallout 4 couldn't override the game's own setting, while Nvidia's drivers managed to override the game's own refresh rate setting without a problem.

Of course, Radeon Software has only just launched, so there are bound to be a few teething issues, but overall, we think AMD is moving in the right direction with its new driver software.



Installed games are automatically detected, and you get customisable profiles for each of them



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Asus Radeon R9 380 Strix 2GB / £160 inc VAT

SUPPLIER www.dabs.com

Asus' Radeon R9 380 Strix 2GB is both the longest and tallest AMD card on test, with its 272 x 138mm dimensions throwing out any notion of squeezing it into a small case. The upside of this size, though, is that you get enough space for good heat dissipation, along with a quiet, efficient and semi-passive cooler.

Asus hasn't gone wild with its out-of-the-box overclock either. In fact, it isn't much faster than the smallest R9 380 card on test. The GPU core sits at 990MHz, just 20MHz over the stock speeds, which is the equivalent of a 2 per cent boost. Meanwhile, its memory frequency is the same as the reference R9 380 spec, 5.5GHz (effective).

But the overclock isn't the focus of this card, which the external packaging makes clear with its claim of '0dB gaming' for extremely low noise output. On its website, Asus explains that this feature results in complete silence from the card during light gaming, and 20 per cent less noise during more intense scenes. Its default Low fan speed profile spins the fan at just 904rpm.

Aside from the cooler, the R9 380 Strix package has a modest feature set. There's a backplate, but no dual BIOS feature and no adaptors or extra accessories, while the video outputs simply include dual-link

DVI-I and DVI-D, HDMI and DisplayPort. The only remaining notable addition is an LED power indicator over the 8-pin PCI-E connector, which indicates when a solid connection has been made.

With a minimal overclock, performance is only a slim improvement over the reference R9 380, and the Asus Radeon R9 380 Strix 2GB is the slowest card on test. The difference isn't really noticeable in *The Witcher III*, but in *Fallout 4*, the Sapphire R9 380 Nitro 4GB adds 5fps to the Strix's minimum frame rate.

We then decided to see if we could squeeze any more performance out of the card, and managed to raise the GPU frequency by 130MHz to 1120MHz, and took the memory up to 6.3GHz (effective).

However, unlike the other cards on test, the Strix required a voltage injection of 50mV to achieve these clock speeds. At these settings, the *Fallout 4* minimum frame rate went from 29fps to 32fps at 1080p, which is a solid improvement, even if it still can't quite catch the Sapphire.

Load power consumption in our test PC was 291W with the Strix at stock speed and 331W when it was overclocked, which is about right for a card of this spec, and nothing extraordinary. Temperatures were good though. When idle, the Asus Radeon R9 380 Strix's GPU hit a delta

T of 14°C, but under load it was the coolest R9 380 card on test, hitting just 43°C, a result that's 11°C (around 25 per cent) cooler than either of Sapphire's cards.

What's more, despite these temperatures, the cooler was also the quietest on test – you can hardly hear it in use.

Conclusion

Although the Asus Radeon R9 380 Strix doesn't come with loads of accessories, and isn't much faster than a stock card, we must stress that the performance difference between the 2GB cards on test is very slim. If speed is your priority, the extra memory on the Sapphire R9 380 Nitro Backplate 4GB gives it an edge in *Fallout 4* at 1080p, but the Asus Radeon R9 380 Strix's superb cooler means it strikes the perfect balance between fan noise, temperatures and performance, and at a reasonable price too.

VERDICT

The quietest and coolest R9 380 card on test, while still remaining fast. A great graphics card for the money.

DESIGN & FEATURES

41/45

PERFORMANCE
22/25

VALUE
27/30

OVERALL SCORE

90%



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Sapphire Radeon R9 380 ITX Compact OC 2GB / £153 inc VAT

SUPPLIER www.scan.co.uk

As its name suggests, the Sapphire Radeon R9 380 ITX Compact OC has a small PCB, with an overall package that's designed to fit into a compact mini-ITX chassis where space is at a premium. It measures just 171mm long, making it just 1mm longer than a mini-ITX board. Its height of 107mm means it's quite short too.

With no room for a substantial cooler, the default overclock only raises the clock frequencies by a small amount, with a 980MHz core and 5.6GHz (effective) for the memory, mere increases of 1 per cent and 1.8 per cent respectively.

However, it's good to see at least a small overclock has been applied – it's hard to imagine squeezing much more from a card with such diminutive dimensions. Not surprisingly, only a 2GB version is offered, with no 4GB version available.

Meanwhile, there are four video outputs, including dual-link DVI-I and HDMI, which join a pair of mini-DisplayPort outputs. Mini-DisplayPort isn't ideal, but we assume this compromise provides some extra space for rear heat exhaustion. Thankfully, there's a DisplayPort adaptor included in the box, along with a DVI to VGA adaptor and an adaptor to convert two 6-pin PCI-E plugs into one 8-pin plug. Then there's the cooler itself, which is a traditional active type with a single fan. There's no backplate, but you do get a dual BIOS for both legacy and UEFI motherboards.

The default overclock on the Sapphire Radeon R9 380 ITX Compact OC is more



It's hard to imagine squeezing much more from such a diminutive graphics card

modest than the other R9 380 cards on test, so its out-of-the-box performance is generally lower. The Fallout 4 1080p minimum of 29fps is a full 5fps lower than the 4GB Sapphire R9 380 Nitro's result, but the full-sized Asus Strix card isn't any faster in this test either.

In all the other tests, the differences between the four cards aren't as noticeable either – we're talking about slim margins.

We also managed to squeeze a good manual overclock from the Sapphire Radeon R9 380 ITX Compact OC, raising its core clock by 120MHz to 1090MHz, and its memory clock to 6.6GHz, without adding any voltage. These settings improved the Fallout 4 results slightly, with an increase in minimum frame rate to 31fps at 1080p.

One advantage of the card's small size, though, is its lower power requirements. At its out-of-the-box clock frequency, the power consumption of our test PC at load was the lowest on test, at just 284W, which jumps to 307W when the card is overclocked. The latter is still a very reasonable figure, kept down by

the lack of extra voltage. It runs fairly cool at idle too, with a GPU delta T of just 12°C, but this temperature hits 54°C under load. On the plus side, the noise levels are lower than expected given the single fan, and we recorded a fan speed of 1,517rpm. It isn't the quietest card on test, but it's not loud either.

Conclusion

The Sapphire Radeon R9 380 ITX Compact OC 2GB might not be exceptionally fast, or offer the near-silent operation and low temperatures of its full-sized competitors, but that's hardly surprising when you consider its size, and that's this card's main selling point. If you're building a full-sized ATX PC, then you'll be better off with the Asus Radeon R9 380 Strix 2GB, but if space is at a premium, this compact card still manages to offer solid performance, surprisingly quiet operation and decent value for money.

VERDICT

Not the fastest, quietest or coolest card on test, but if space is at a premium, this compact card is still surprisingly capable.

DESIGN & FEATURES

34/45

PERFORMANCE
22/25

VALUE
25/30

OVERALL SCORE

81%



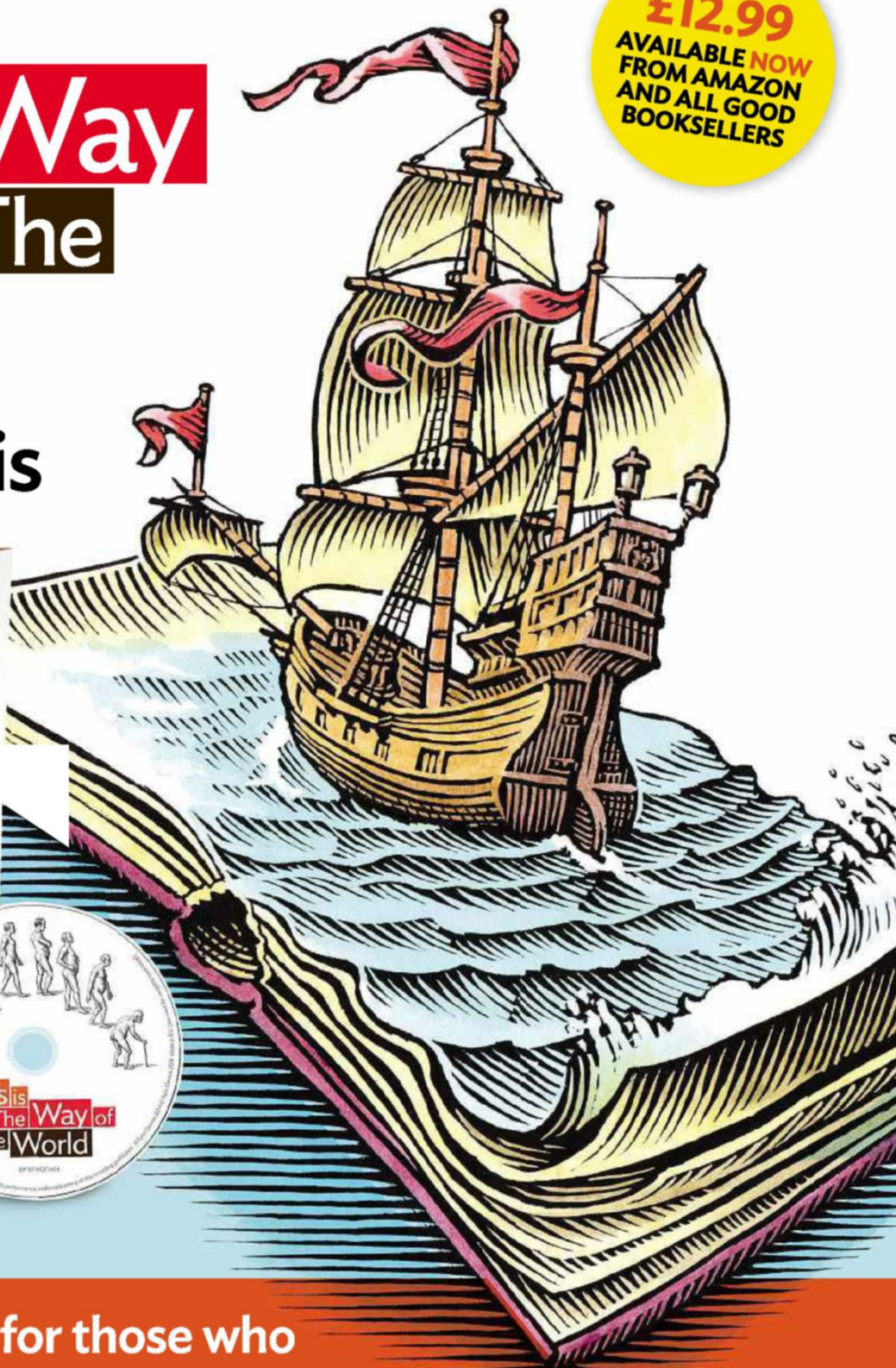
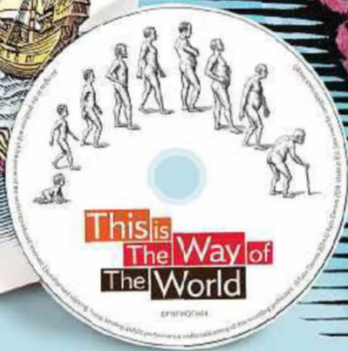
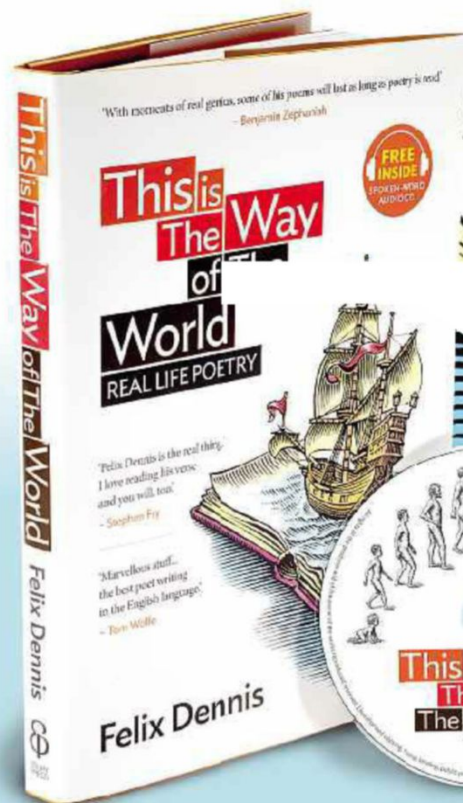
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Sapphire R9 380 Nitro Backplate 4GB / £175 inc VAT

SUPPLIER www.ebuyer.com

Sapphire's R9 380 Nitro Backplate 4GB is the only 4GB card on test, and thus the priciest, so it will be interesting to see how much difference the extra memory makes. It's a sizeable card too, measuring 237mm long and 125mm high, so it isn't built for compact cases.

There are quite a few additional features as well, including a backplate (as the name suggests), as well as DVI to VGA adaptor and a dual BIOS setup.

On the back, you'll find the standard video outputs, including dual-link DVI-I and DVI-D, HDMI and DisplayPort. Meanwhile, the Nitro's clock speeds aren't quite as high as those on the XFX Radeon R9 380 DD Black Edition, but there's still an impressive 40MHz overclock (4.1 per cent), applied to the core, taking it to 1,010MHz, with the memory frequency raised by 5.4 per cent to 5.8GHz (effective).

With these clock speeds and the extra memory, we see some great performance, with the Nitro managing a stunning 34fps minimum in Fallout 4 at 1080p with Ultra detail. Its 33fps minimum in Shadow of Mordor at 2,560 x 1,440 is also a great result, although its performance in The Witcher III was very similar to the other R9 380 cards on test.



The card isn't particularly cool or power-efficient though. The idle power consumption of our test PC was 115W with this card, higher than the other R9 380 cards on test, and it hit 297W under load. The 54°C GPU delta T is also comparatively hot. The Nitro's cooler is quiet though, with the default fan profile spinning at 973rpm, almost as low as the fan on the Asus R9 380 Strix, and you can barely hear it when it spins up.

We also achieved our manual overclock with no extra voltage, adding another 100MHz to the out-of-the-box clock speeds, taking the GPU core to 1110MHz (a 14.4 per cent boost over the stock frequency). We raised the memory frequency to 6.4GHz (effective), representing a 16.3 per cent boost over stock speed. When overclocked, the card made our test system consume 332W under load, which isn't the highest power consumption on test, but it's not exactly frugal either.

At these speeds, we saw some superb results from our Fallout 4 test, though, mainly thanks to the extra memory. At 1080p, it clocked up a superb minimum frame rate of 37fps, 4fps faster than any other R9 380 card on test.

From these results, we can see that the extra memory gives you a

decent boost in Fallout 4 at 1080p with Ultra detail. It isn't the difference between the game being playable or not, but it's a welcome boost for only a little bit more cash.

Conclusion

We've been unconvinced of the benefits of piling loads more memory than usual onto a graphics card, but in this case, the extra 2GB of memory makes a noticeable difference in Fallout 4 at 1080p, making the Sapphire R9 380 Nitro Backplate 4GB our card of choice in our Fallout 4 PC this month (see p84). As a general package, the Asus Strix card's superb cooler still makes it our card of choice, especially as there's a 4GB version available.

However, while the R9 380 Nitro 4GB runs a little hotter than the Asus, it has some extra accessories and features too. If performance is your top priority, then the Sapphire R9 380 Nitro Backplate 4GB is a great choice.

VERDICT

A great choice if performance is your top priority, particularly in Fallout 4.

DESIGN & FEATURES		OVERALL SCORE
40/45		
PERFORMANCE	VALUE	89%
24/25	25/30	



XFX Radeon R9 380 DD Black 2GB / **£150** inc VAT

SUPPLIER www.ebuyer.com

The DD in the name of the XFX R9 380 DD Black Edition stands for 'double dissipation', an obvious reference to the enhanced performance from the dual-fan cooler that sits on top the card. In theory, this extra airflow means greater headroom for higher clock speeds, and XFX has taken full advantage of this situation, with this card offering the highest stock speeds of any of the R9 380 cards on test.

The core clock is 1030MHz, representing a 60MHz increase from the R9 380 stock speed, or 6.2 per cent, while the 5.8GHz (effective) memory frequency is 5.4 per cent higher than the stock clock frequency. However, the cooler is fully active, unlike the semi-passive coolers on some of the other R9 380 cards on test.

It also has an aggressive default fan profile, which makes the XFX R9 380 DD Black the loudest R9 380 card in this Labs test, with the fans spinning at an average speed of 2,776rpm.

Basically, XFX has taken the opposite approach to Asus when it comes to cooling. Asus has used the extra headroom from its cooler to optimise its card for quieter performance; XFX has gone with greater performance. The card itself is also 239mm long, so it's a fair bit

smaller than the Asus Strix card, and a 4GB variant is also available.

Move to the back and you'll find dual-link DVI-I and DVI-D outputs, plus DisplayPort and HDMI sockets. No adaptors are bundled inside the box though – the only extra is a pair of dual Molex to 6-pin PCI-E adaptor cables. There's notably no backplate or dual BIOS system as part of the offering either.

At stock speeds, the XFX R9 380 DD Black Edition does well, offering the best performance in The Witcher III at both 1080p and 2,560 x 1,440, even beating Sapphire's R9 380 Nitro 4GB. It beats the other 2GB cards on test in Shadows of Mordor and Fallout 4 too, albeit by a very slim margin.

The XFX Radeon R9 380 DD Black also proved to be a solid card for overclocking, on top of the already impressive clock frequencies. We raised its core clock to 1160MHz, taking its final overclocked frequency to 190MHz over stock speeds, and took the memory up to 6.6GHz (effective).

The one downside of all this overclocking headroom, and the high out-of-the-box clock speeds, of course, is power consumption. Our test system drew 300W under load with the XFX running at its default speeds, and 344W when manually

overclocked. Thanks to the high fan profile, the XFX is also the coolest card on test when idle, with the GPU delta T hovering around 7°C, which rose to 46°C under load. Comparatively, though, the lower-clocked Asus Strix card's GPU delta T was just 43°C, and its cooler is significantly quieter than that of the XFX card.

Conclusion

The XFX R9 380 DD Black Edition is well priced, performs very well at both stock and overclocked frequencies, and runs at a low idle temperature. However, the performance difference between this card and other 2GB cards is slim, and you pay a price in terms of fan noise and higher power consumption. Asus' Radeon R9 380 Strix 2GB may not be quite as quick or cheap, but it strikes a better balance, remaining cool and quiet while still offering solid performance.

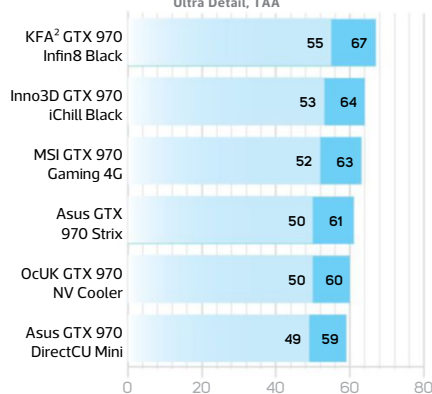
VERDICT

A tempting price and fast performance, but it's let down by a noisy cooler and high power consumption.

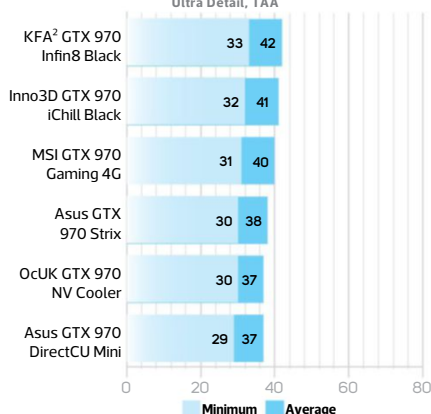
DESIGN & FEATURES		OVERALL SCORE
29/45		
PERFORMANCE	VALUE	82%
27/25	26/30	

NVIDIA GEFORCE GTX 970 CARDS

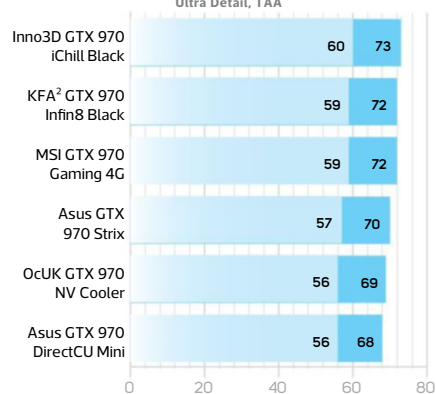
FALLOUT 4
1,920 X 1,080 (FPS)
Ultra Detail, TAA



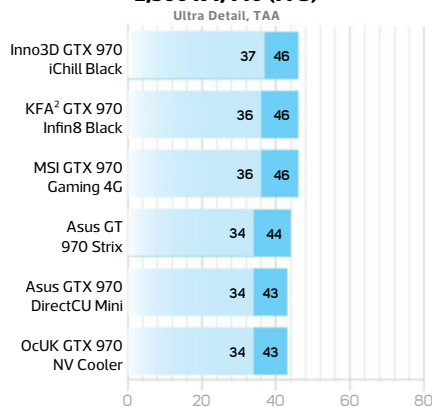
FALLOUT 4
2,560 X 1,440 (FPS)
Ultra Detail, TAA



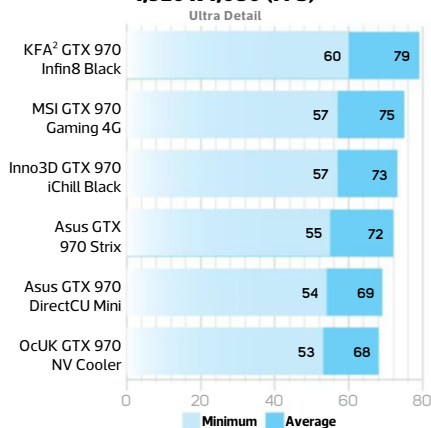
OVERCLOCKED FALLOUT 4
1,920 X 1,080 (FPS)
Ultra Detail, TAA



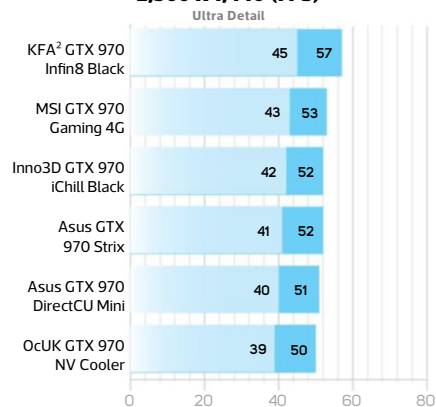
OVERCLOCKED FALLOUT 4
2,560 X 1,440 (FPS)
Ultra Detail, TAA



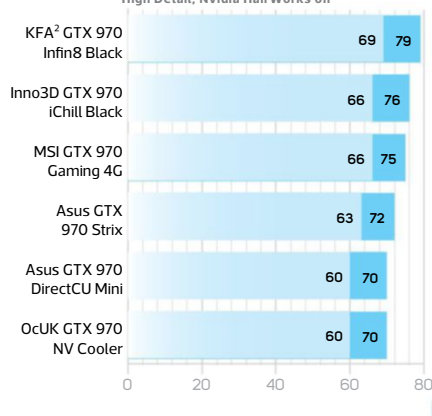
MIDDLE EARTH: SHADOW OF MORDOR
1,920 X 1,080 (FPS)
Ultra Detail



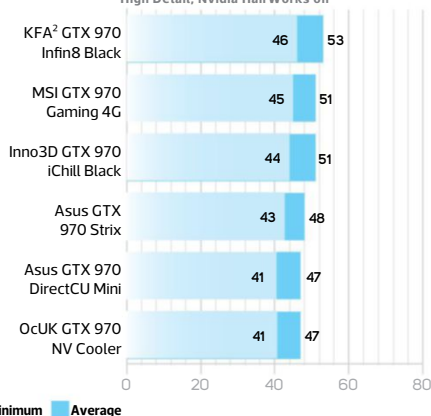
MIDDLE EARTH: SHADOW OF MORDOR
2,560 X 1,440 (FPS)
Ultra Detail



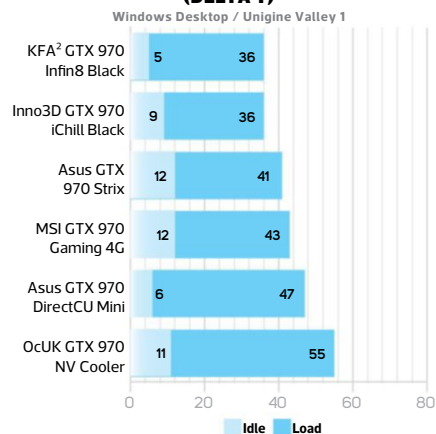
THE WITCHER 3: WILD HUNT
1,920 X 1,080 (FPS)
High Detail, Nvidia HairWorks off



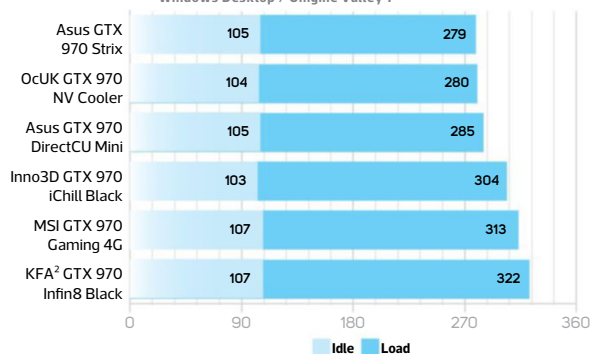
THE WITCHER 3: WILD HUNT
2,560 X 1,440 (FPS)
High Detail, Nvidia HairWorks off



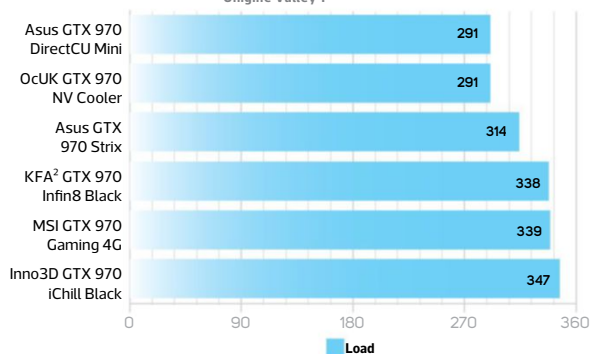
TEMPERATURE (DELTA T)
Windows Desktop / Unigine Valley 1



TOTAL SYSTEM POWER CONSUMPTION (WATTS)
Windows Desktop / Unigine Valley 1



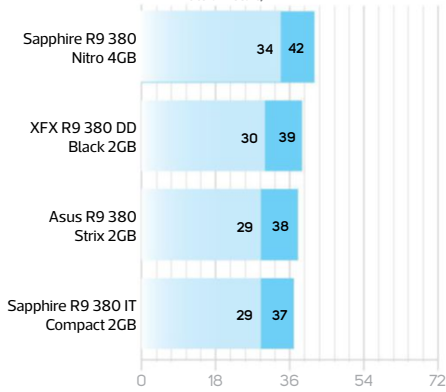
OVERCLOCKED TOTAL SYSTEM POWER CONSUMPTION (WATTS)
Unigine Valley 1



AMD RADEON R9 380 CARDS

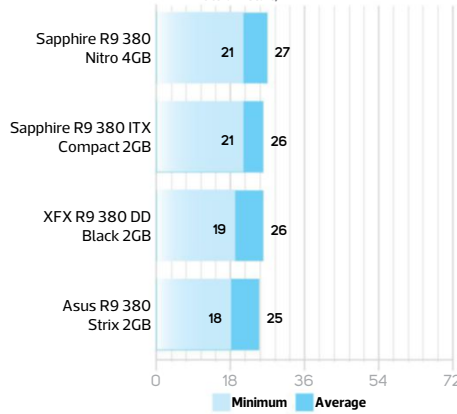
FALLOUT 4 1,920 X 1,080 (FPS)

Ultra Detail, TAA



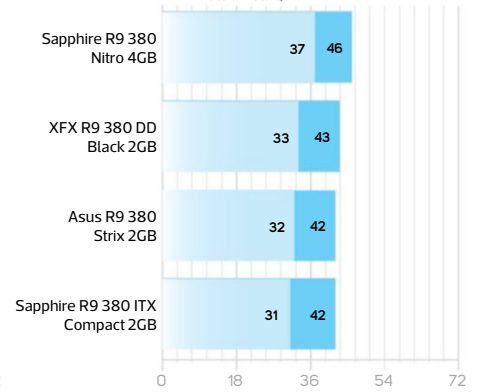
FALLOUT 4 2,560 X 1,440 (FPS)

Ultra Detail, TAA



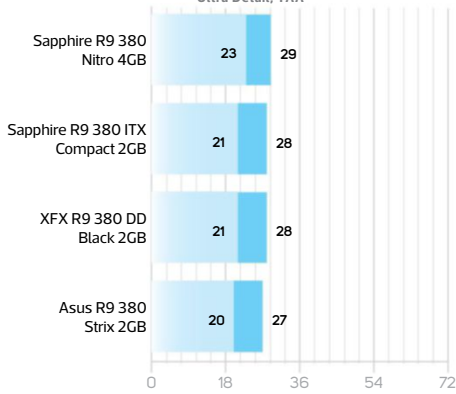
OVERCLOCKED FALLOUT 4 1,920 X 1,080 (FPS)

Ultra Detail, TAA



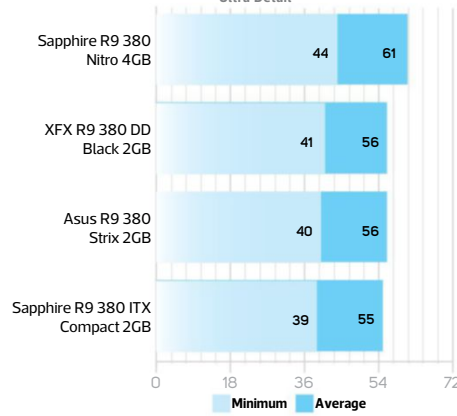
OVERCLOCKED FALLOUT 4 2,560 X 1,440 (FPS)

Ultra Detail, TAA



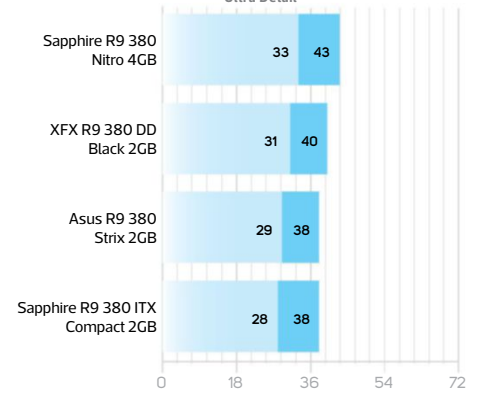
MIDDLE EARTH: SHADOW OF MORDOR 1,920 X 1,080 (FPS)

Ultra Detail



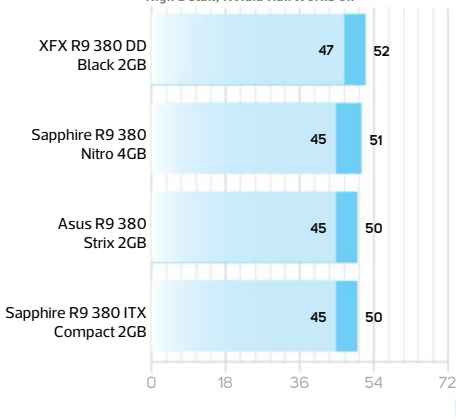
MIDDLE EARTH: SHADOW OF MORDOR 2,560 X 1,440 (FPS)

Ultra Detail



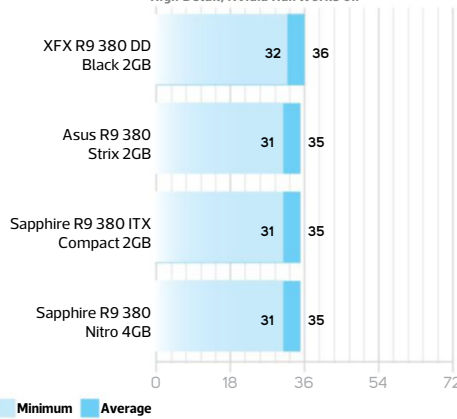
THE WITCHER 3: WILD HUNT 1,920 X 1,080 (FPS)

High Detail, Nvidia HairWorks off



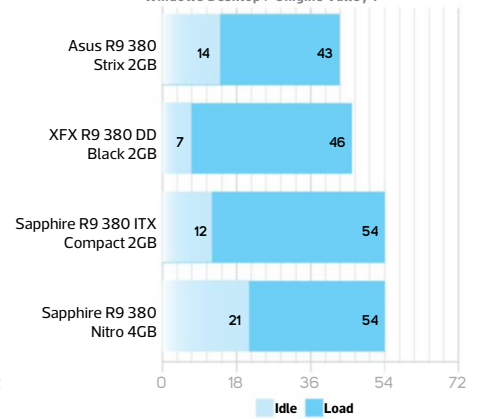
THE WITCHER 3: WILD HUNT 2,560 X 1,440 (FPS)

High Detail, Nvidia HairWorks off



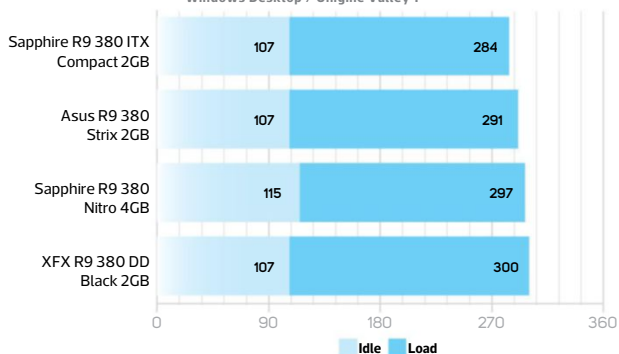
TEMPERATURE (DELTA T)

Windows Desktop / Unigine Valley 1



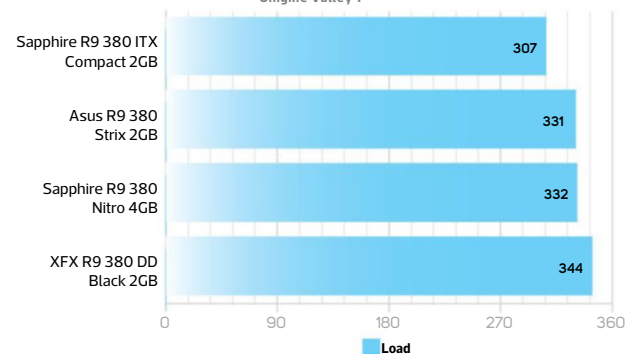
TOTAL SYSTEM POWER CONSUMPTION (WATTS)

Windows Desktop / Unigine Valley 1



OVERCLOCKED TOTAL SYSTEM POWER CONSUMPTION (WATTS)

Unigine Valley 1



PC system reviews

GAMING PC

CyberPower Infinity X77 Deluxe / £1,999 inc VAT

SUPPLIER www.cyberpowersystem.co.uk

CyberPower's Infinity X77 Deluxe arrives inside a case that shines with tempered glass. The daring design comes courtesy of In Win's 805. Its side panels and front cover are made entirely from thick glass, the front of the side panels have smart In Win logos, the whole case sits on subtle plastic feet and the skeleton beneath the glass is hewn from aluminium.

It looks fantastic. The gleaming glass panels are also complemented with a blue strip light in the roof; every component is bathed in light, and it's all visible. That blue light works well with the glass front panel too; it's decorated with a honeycomb pattern that glows with light from behind.

On the inside, the PC is more conventional. The radiator for the Corsair Hydro H110i GTX CPU cooler is attached

vertically at the front, there's a storage bay beneath and the middle of the chassis is dominated by the graphics card. Meanwhile, the Corsair CX750M PSU isn't modular, but CyberPower has carefully routed its cables, making good use of the space behind the case's motherboard tray and the generous routing holes. Of course, you need to have a neat build in a case with glass side panels, since every component is visible, and CyberPower has done a great job here.

CyberPower has delivered decent specs too. The Core i7-6700K has had its four Hyper-Threaded cores overclocked from 4GHz to a massive 4.7GHz, and it's bolstered by 16GB of 3000MHz RAM too. Meanwhile, the MSI GeForce GTX 980 Ti card isn't an overclocked model, but it still has 2,816 stream processors.

The storage is great too. The 400GB Intel 750 Series SSD uses the fast PCI-E interface and NVMe protocol rather than slower SATA/AHCI, and it's paired with a 2TB hard disk.

Many of the components are enthusiast-level, and the Asus Maximus VIII Ranger motherboard follows suit, even if you wouldn't know it to look at its plain metal heatsinks. The mundane aesthetics conceal impressive features though. There are power and reset

buttons at the bottom of the board and a two-figure POST display at the top, and SupremeFX circuitry to improve the audio. The back panel is packed too, with USB 3.1 Type-A and Type-C connectors for future proofing, and two further USB 3 ports alongside four USB 2 connectors. There's also a clear-CMOS button and five audio jacks.

There's the usual array of slots too, but the large graphics card, Wi-Fi adaptor and PCI-E SSD mean most of these slots are occupied or blocked. There's only one 16x PCI-E slot and two 1x PCI-E slots free – and even then it's tricky to add components between existing cards.

Elsewhere, expansion potential is more obvious. There's an M.2 socket and several free SATA connectors, and there's a single free side-facing 3.5in bay and four empty 2.5in bays behind the motherboard tray.

Finally, CyberPower's warranty covers labour for three years, while the all-important parts coverage lasts two years. There's only six months of collect and return cover though – it reverts to a return to base deal afterwards.

Performance

The presence of a GTX 980 Ti moves the CyberPower above most of the single-card systems we've seen recently. While machines such as the Eclipse i7 Liquid Vengeance (see Issue 149, p58) just about get their fingertips into the 4K world thanks to GTX 980 cards, the Infinity X77 Deluxe uses the 980 Ti's extra stream processors to easily ascend to 3,840 x 2,160 gaming. In Battlefield 4 at 4K, the CyberPower's minimum of 37fps is comfortably smooth, and the CyberPower led the way in Crysis 3 too: its 4K minimum of 29fps hits our minimum playable frame rate target, a feat that neither the Eclipse i7 Liquid Vengeance, nor the £1,999 Box Cube Predator (see Issue 147, p58) could achieve.

Needless to say, the Infinity X77 Deluxe also handled 2,560 x 1,440 gaming fine: its Battlefield 4 pace of 62fps was its best, but it still romped through Shadow of Mordor and Crysis 3 to scores of 56fps and 43fps. The CyberPower also has a helping hand from the massive overclock applied to its Core i7-6700K – 4.7GHz is an amazing speed to be guaranteed by a system builder and it pays off in application



/SPECIFICATIONS

CPU 4GHz Intel Core i7-6700K overclocked to 4.7GHz

Motherboard Asus Maximus VIII Ranger

Memory 16GB Corsair Vengeance LPX 3000MHz DDR4

Graphics MSI GeForce GTX 980 Ti 6GB

Storage Intel 750 Series 400GB SSD; 2TB Seagate hard disk

Case In Win 805

Cooling CPU: Corsair Hydro H110i GTX with 2 x 140mm fans GPU: 1 x 60mm fan; rear: 1 x 120mm fan

PSU Corsair CX750M 750W

Ports Front: 1x USB 3.1 Type-C, 1x USB 3, 2x USB 2, 2x audio; rear: 1x USB 3.1 Type-A, 1x USB 3.1 Type-C, 2x USB 3, 4x USB 2, 1x PS/2, 1x Gigabit Ethernet, 1x optical S/PDIF, 5x audio

Operating system Windows 10 Home 64-bit

Warranty Two year parts, three years labour. Six months collect and return, then return to base

- 1** The super-fast Intel 750 SSD comes on a PCI-E card
- 2** The CPU has been given a massive boost to 4.7GHz
- 3** The dual-fan Corsair H110i GTX cooler is mounted at the front

benchmarks. The CyberPower's image editing result of 68,900 outpaces the Box Cube Predator's 65,279 with its 4.5GHz CPU, and its 329,911 result in the video encoding test is quick too. The CyberPower's system score of 149,808 is excellent, being around 17,000 points ahead of the Eclipse, and more than 4,000 points in front of the Box. This is a very fast Skylake system. The PCI-E Intel SSD is a barnstormer too. In sequential tests, its read and write speeds of 2,053MB/sec and 1,007MB/sec are excellent.

Amazingly, the machine doesn't get too hot either. The CPU and GPU delta Ts of 53°C and 60°C respectively are higher than those of the aforementioned Box PC, but that isn't surprising given the CPU overclock, and neither are cause for concern. Noise, though, is worse from the CyberPower: its low idle fan noise ramps up to a more noticeable level during games, with an obvious rumble that modulates up and down. It's no worse than most gaming PCs, but it's definitely louder than the Box system.

Conclusion

CyberPower's machine costs the same amount of money as the Box Cube Predator and it shares its main components: an overclocked Core i7-6700K processor and GTX 980 Ti GPU. However, the CyberPower is faster in applications thanks to its huge overclock, and it also has a



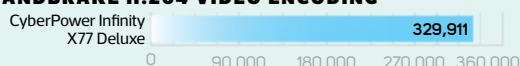
faster primary storage system and the ability to play Crysis 3 at top settings at 4K. The CyberPower also looks fantastic. Its only downsides are the variable noise levels when running at full pelt, and the lack of upgrade room, but those are the compromises you make when buying a fast, fully featured machine – if quiet operation is your priority, the Box system will suit your needs better. However, with its amazing speed, great looks and cracking feature set, the CyberPower is a fantastic high-end gaming system.

MIKE JENNINGS

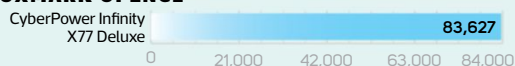
CPC REALBENCH 2015 GIMP IMAGE EDITING



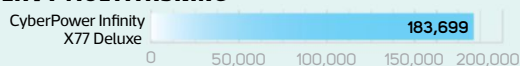
HANDBRAKE H.264 VIDEO ENCODING



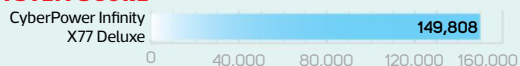
LUXMARK OPENCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 130.89%

SPEED
23/25

HARDWARE
22/25

DESIGN
23/25

VALUE
20/25

OVERALL SCORE

88%

BATTLEFIELD 4

2,560 x 1,440, Ultra Detail, 4x AA



3,840 x 2,160, Ultra Detail, 4x AA



SHADOW OF MORDOR

2,560 x 1,440, Ultra Detail, FXAA



3,840 x 2,160, Very High Detail, FXAA

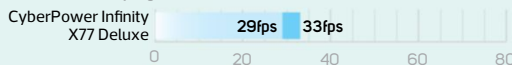


CRYSIS 3

2,560 x 1,440, Very High Detail, 0x AA



3,840 x 2,160, Very High Detail, 0x AA



Minimum Average

VERDICT

An amazing overclock and impressive 4K gaming performance, all packed into a striking case.

GAMING PC

Overclockers Infin8 Toxicity / **£3,414** inc VATSUPPLIER www.overclockers.co.uk

Overclockers is rarely shy with its PC builds, but its latest machine – the Infin8 Toxicity – is extravagant even by the Stoke firm's lofty standards. Its Phanteks Enthoo Primo Special Edition case is an absolute monster, and the green and black colour scheme ensures this machine lives up to its name.

The Phanteks Enthoo Primo chassis has an exterior made of black aluminium, and a far more colourful interior is visible through the vast side window. A huge slab of steel at the front, the motherboard tray and the shroud that hides the vertical PSU all stand out thanks to their bright green finish.

Meanwhile, an EKWB X3 250 reservoir sits in the middle of the case and bubbles with green Mayhems liquid, with half the pipes that course through the graphics card blocks and CPU block filled with the same coolant. The Gigabyte motherboard is finished with green heatsinks and slots too, and half of the individually braided graphics power cables are green as well. For contrast, half of the water-cooling tubes, the motherboard PCB, the GPU waterblocks, the cable-routing holes and the memory are all black, with the whole lot sandwiched between two EKWB Coolstream XE radiators, each equipped with SilverStone 120mm fans.

The interior is then illuminated with white lights, and a band of light around the recessed front section glows green, although there's a button to turn off this light if you want. Build quality, not surprisingly, is also rock-solid; this case is a tank. The PC is also a huge, heavy system. It measures 650mm tall and 600mm deep, and weighs around 25kg.

The Toxicity looks fantastic and, despite its sub-£3,500 price, it looks nearly as good as some of the more affordable Dream PCs we've seen this year. The Toxicity's stunning, two-tone design also houses suitably high-end hardware. Two Nvidia GeForce GTX 980 Ti cards are deployed, and they've been individually tweaked by Overclockers' technicians, so no two PCs will have precisely the same overclock. In our sample, the graphics cards' GPU cores were overclocked from 1000MHz to a mighty 1465MHz, and the memory frequency was increased from 1753MHz to 1900MHz.

The team has applied its talents to the Core i7-6700K too. The quad-core, Hyper-Threaded chip has been boosted from 4GHz to 4.7GHz, and it's paired with 16GB of 2666MHz DDR4 memory.

The storage setup is high-end too. The OS is installed on a high-speed Samsung SM951 M.2 NVMe SSD, which uses the PCI-E bus, but there's also a SATA SSD and a 3TB hard disk for extra storage space.



The Gigabyte G1.Sniper Z170 motherboard has some neat touches too, in addition to the green and black colour scheme. Its dedicated audio circuit lights up, for example, and it has USB 3.1 Type-A and -C alongside more conventional connections on the back. It's missing enthusiast features such as on-board power and rest buttons and a POST display though.

There's a good three year warranty too, which includes two years of collect and return coverage for parts and labour, with a third year of return to base, labour only coverage.

Performance

The presence of two GTX 980 Ti GPUs means that there isn't a game around that the Toxicity can't handle, even at 4K. With Battlefield 4 running at its highest settings at 4K, the Toxicity hit an impressive minimum of 72fps. Its 89fps minimum in Shadow of Mordor at 4K, with Very High settings, was even better, and this speed only dropped to 81fps when we ramped up the game to its Ultra settings.

Even our old but punishing Crysis 3 benchmark couldn't stop this machine, with a solid 45fps minimum at 4K, and the game even remained playable when we activated 8x anti-aliasing, with a 30fps minimum. Those results are stellar, and competitive with some of the results from the cheaper machines in our Dream PC Labs.

The generous CPU overclock ensures excellent application performance too. With its 4.7GHz clock speed, the Toxicity's image editing score of 63,941 outpaced four of the six Dream PCs in that Labs test, and its video encoding score of 336,024 is also good, even if it can't catch the lofty standards set by Haswell-E systems. The Overclockers' overall score of 154,506 is excellent. It can't match any of the Haswell-E Dream PCs, but it's more than enough power for apps and games. Unless you use a lot of heavily multi-threaded software, this machine is plenty powerful enough.

/SPECIFICATIONS

CPU 4GHz Intel Core i7-6700K
overclocked to 4.7GHz

Motherboard Gigabyte G1.Z170
Sniper

Memory 16GB Kingston HyperX
Fury Black 2666MHz DDR4

Graphics 2x Zotac GeForce GTX
980 Ti 6GB

Storage 512GB Samsung SM951
M.2 SSD; 500GB Samsung 850
Evo SSD; 3TB Seagate Barracuda
hard disk

Case Phanteks Enthoo Primo
Special Edition

Cooling CPU and GPU: EKWB
EX-250 Reservoir, Coolstream
XE 240 & 360 radiators, 2x
EKWB Nickel GPU waterblocks,
EKWB Supremacy EVO CPU
waterblock, 5x 120mm fans;
rear: 1x 140mm fan

PSU Super Flower Leadex
1300W

Ports Front: 2x USB, 2x USB 2, 2
x audio; Rear: 1x USB 3.1 Type-A,
1x USB 3.1 Type-C, 3x USB 3, 2x
USB 2, 1x PS/2, 1x Gigabit
Ethernet, 6x audio

Operating system Windows 10
64-bit

Warranty Two years parts and
labour collect and return,
followed by one year return to
base labour only



Meanwhile, the Samsung SM951 SSD's sequential read and write speeds of 1,782MB/sec and 1,194MB/sec respectively far outpaced any SATA-based SSD.

The extensive water cooling meant that heat was never an issue either. The processor's delta T of 55°C is fine, especially with such a large overclock, and the liquid kept the GPUs down to a chilly 46°C delta T as well. The one price you pay for all that computing muscle is the bill for power consumption. The Toxicity drew 818W from the mains at full pelt, which is high, but not surprising from such a monster machine.

Thanks to the custom water-cooling loop, the Toxicity also keeps the noise down to a barely audible hum during less intensive tasks, and doesn't get too loud during games either. The only time the Toxicity's noise caused an issue was during stress tests, where it produced a loud, consistent rumble. However, we only reached that level by stressing the main components at 100 per cent load.

Conclusion

The Overclockers Infin8 Toxicity is expensive, but it's easy to see where the money has gone. The build quality is exquisite, and the green and black theme is colourful and



1
A combination of clear and black tubing makes a great contrasting effect with the green coolant

2
The system is sandwiched between two thick EKWB Coolstream XE radiators

3
The pair of water-cooled GTX 980 Ti graphics cards make light work of 4K gaming

coherent. It's a rapid performer, too: almost as fast as our Dream PCs in games and applications. The price saving over a Dream PC means that the Toxicity loses out when it comes to heavily multi-threaded software and exterior customisation, but that's about it. It's an unashamedly high-end machine with a well-considered spec and great internal looks. If you want a gorgeous and exceptionally fast PC, but balk at the cost of the machines in our Dream PC Labs, the Toxicity is an excellent and marginally cheaper alternative.

MIKE JENNINGS

CPC REALBENCH 2015

GIMP IMAGE EDITING



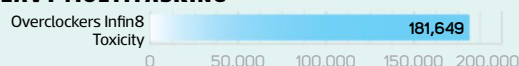
HANDBRAKE H.264 VIDEO ENCODING



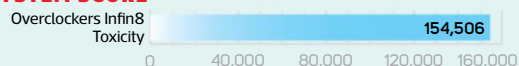
LUXMARK OPENCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 135%

SPEED
24/25

DESIGN
24/25

HARDWARE
24/25

VALUE
21/25

OVERALL SCORE
93%

BATTLEFIELD 4

2,560 x 1,440, Ultra Detail, 4x AA



3,840 x 2,160, Ultra Detail, 4x AA



SHADOW OF MORDOR

2,560 x 1,440, Ultra Detail, FXAA



3,840 x 2,160, Ultra Detail, FXAA

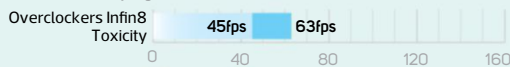


CRYSIS 3

2,560 x 1,440, Very High Detail, 0x AA



3,840 x 2,160, Very High Detail, 0x AA



Minimum Average

VERDICT

Incredible speed and a stunning build make the Toxicity a formidable 4K gaming rig.

GAMING PC

Chillblast Fusion Hellfire / £2,000 inc VAT

SUPPLIER www.chillblast.com

We've seen all manner of brash, colourful systems in **CPC** recently, making the Chillblast Fusion Hellfire look comparatively sedate, but appearances can be deceptive – this system houses two GTX 980 GPUs and an overclocked 6-core processor.

It's all housed in a Cooler Master MasterCase 5 chassis, a subtle, matt black enclosure that hides ample features behind smart lines and low-key panels. It's designed using Cooler Master's FreeForm Modular System, so many of the chassis components can be popped off or moved around. The top panel with its handles slides away, the front section with its dust filter snaps out of place, and the hard disk and optical drive cages can be mixed and matched. There are also two 2.5in bays that can be attached to the PSU shroud or the rear of the motherboard tray, and the optical drive bay can be relocated too.

This system extends to an online store where new case components are sold, although only the top section, hard disk bays and side panels are available here, and only in black too. It's a decent case, though, and the brooding exterior design follows through to the inside. The case's black metal insides complement the Asus motherboard's black PCB topped with dark grey heatsinks, and the pair of Asus Strix GPUs are mostly black too. The dark effect is completed by the large dual-fan Corsair H100i GTX radiator in the roof.

Those components also promise impressive performance. The two Strix GTX 980s ramp up the core GPU clock from 1126MHz to 1178MHz, which means a revised base clock of 1279MHz. Chillblast has also gone down an interesting route with its choice of a Core i7-5820K processor. This Haswell-E chip doesn't have the new Skylake architecture of the Core i7-6700K that appears in many gaming PCs, but it does have six Hyper-Threaded cores, and Chillblast has boosted its 3.3GHz stock speed to 4.2GHz.

There's more memory than most PCs offer too, with Chillblast offering 32GB of 2133MHz DDR4 RAM with this machine – twice as much as we're used to seeing. It won't make any difference to games, but it could be handy for anyone running workstation software or multiple virtual machines.

Storage-wise, it's business as usual. The boot drive is a 256GB Samsung SM951M.2 NVMe SSD, which uses the PCI-E bus, and there's a 3TB hard disk for extra data storage too. Meanwhile, the Asus X99-A/USB 3.1 is a solid mid-range motherboard with an on-board POST display and a couple of on-board buttons, along with two USB 3.1 connectors and four USB 3 ports on the back. As it's an older board, there are no USB 3.1 Type-A or -C ports though. The huge graphics cards also

restrict upgrade room on the board – there's a couple of PCI-E slots free, technically, but they're near impossible to reach, and it's the same situation with SATA ports.

Meanwhile, Chillblast's standard warranty is a generous five year deal with two years of parts coverage with a collect and return service, followed by three years of labour only, return to base cover.

Performance

The 6-core processor makes for an interesting battle against the quad-core Core i7-6700K inside the CyberPower Infinity X77 Deluxe this month. Take the image editing test, where the Chillblast scored 47,023. That's reasonable speed, but the CyberPower's superior single-threaded performance, thanks to its monster overclock, meant it romped through at 68,900.

The tables turned in our heavily multi-threaded video encoding benchmark, though, where those six cores can stretch their legs: the Chillblast's result of 368,544 is more than 35,000 points beyond its Skylake competitors. The Fusion Hellfire's overall result of 155,791 is excellent – enough to ensure it won't balk at any task. It's a tad quicker than the CyberPower's 149,808 too.

There's a caveat, though, which is that the vast majority of games don't take advantage of six cores. You'll only get an advantage from those extra cores if you run a lot of heavily multi-threaded software.

The pair of GTX 980 GPUs also proved dominant in games tests, providing the power to play games at 4K, and outpacing the CyberPower. In Battlefield 4 at 3,840 x 2,160, the Chillblast's minimum frame rate of 42fps was 5fps beyond the CyberPower and its single GTX 980 Ti. In Shadow of Mordor the Chillblast also managed a superb 63fps minimum at the game's Very High settings – 19fps beyond the CyberPower, and it even returned a smooth 49fps result when we ramped up the game to its Ultra



/SPECIFICATIONS

CPU 3.3GHz Intel Core i7-5820K overclocked to 4.2GHz

Motherboard Asus X99-A/USB 3.1

Memory 32GB Crucial CT8G4DFD8213C16FAD11 2133MHz DDR4

Graphics Asus Strix GeForce GTX 980 4GB

Storage 256GB Samsung SM951M.2 SSD; 3TB Seagate Barracuda hard disk

Case Cooler Master MasterCase 5

Cooling CPU: Corsair Hydro H100i GTX with 2 x 120mm fans; GPU: 4 x 90mm fans; Front: 2 x 120mm fans; rear: 1 x 120mm fan

PSU Corsair RM850 850W

Ports Front: 2 x USB 3, 2 x audio; rear: 2 x USB 3.1, 4 x USB 3, 4 x USB 2, 1 x PS/2, 1 x Gigabit Ethernet, 1 x optical S/PDIF, 5 x audio

Operating system Windows 10 Home 64-bit

Warranty Two years collect and return parts and labour, followed by three years return to base labour only

settings. Our final title, Crysis 3, saw the Chillblast run through at a minimum of 33fps, comfortably sitting beyond our 30fps target, which the CyberPower couldn't meet.

The storage system impressed too. The PCI-E Samsung SSD managed sequential read and write speeds of 1,812MB/sec and 1,215MB/sec respectively, which are great results. It trades blows with the Intel 750 SSD in the CyberPower machine, which had faster reads but slower writes, although the Intel drive does offer more capacity.

In terms of thermals, the CPU and GPU delta Ts of 53°C and 51°C are fine, and the Chillblast didn't make a racket in most tests either: it was near silent when idle and churned out a modest, deep thrum in games – in that respect, it's easily better than the loud CyberPower. The Chillblast was far louder during stress tests, but you'd have to run the CPU and GPU at 100 per cent load to hear the fans at full force.

Conclusion

Chillblast has chosen a subtle, unfussy chassis for its latest build, and it's a double-edged sword. The Cooler Master case is smart and practical, but it doesn't have the gorgeous glass case of the CyberPower, although the Chillblast's internal build is still very neat and tidy. The Chillblast has power where it really counts though. Its two GTX 980 cards convincingly beat the CyberPower in 4K game tests, and the Core i7 processor is quicker in multi-threaded tasks too, although its six cores are overkill for most mainstream users,



1
The pair of GTX 980 cards means this £2,000 machine can easily handle 4K gaming

2
32GB of quad-channel DDR4 memory sits on either side of the processor

3
A Corsair H100i GTX keeps the overclocked CPU cool

as is the 32GB of memory. The CyberPower also offers more PCI-E solid state storage space.

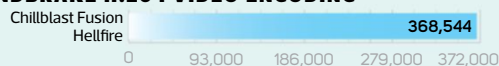
The bottom line, though, is that the Chillblast offers more power than its rivals, especially in games at 4K, thanks to its pair of graphics cards. If 4K gaming performance is your top priority, it's a very fast machine for the money.

MIKE JENNINGS

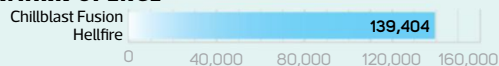
CPC REALBENCH 2015 GIMP IMAGE EDITING



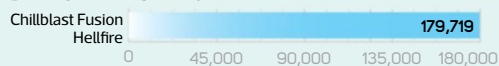
HANDBRAKE H.264 VIDEO ENCODING



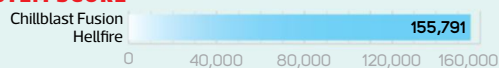
LUXMARK OPENCL



HEAVY MULTITASKING



SYSTEM SCORE



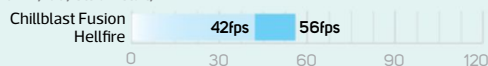
INTEL REFERENCE: 136.12%

BATTLEFIELD 4

2,560 x 1,440, Ultra Detail, 4x AA

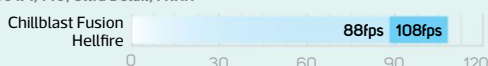


3,840 x 2,160, Ultra Detail, 4x AA

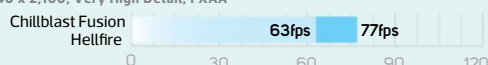


SHADOW OF MORDOR

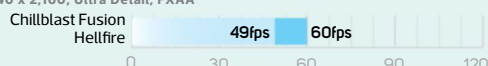
2,560 x 1,440, Ultra Detail, FXAA



3,840 x 2,160, Very High Detail, FXAA

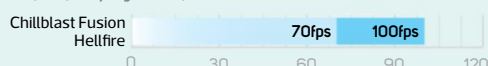


3,840 x 2,160, Ultra Detail, FXAA



CRYSIS 3

2,560 x 1,440, Very High Detail, 0x AA



3,840 x 2,160, Very High Detail, 0x AA



Minimum Average

SPEED
24/25

DESIGN
21/25

HARDWARE
23/25

VALUE
20/25

OVERALL SCORE
88%

VERDICT









An understated-looking system that hides huge gaming power and a 6-core CPU.

Elite

Our choice of the best hardware available

Build a home theatre PC

The parts you'll need to build an affordable, home theatre PC that's ideal for putting in the lounge and playing back all manner of video formats. This machine will handle general computing and media tasks with no trouble, and its dual-core Skylake CPU can even handle 4K video playback. Meanwhile, its super-quiet Noctua CPU cooler prevents it from making a racket.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Lian Li PC-Q09FNB with 300W FSP SFX PSU	www.overclockers.co.uk	Issue 149, p92	£110
	Intel Core i3-6100T	www.overclockers.co.uk	Issue 149, p92	£96
	Asus H110i-Plus D3	www.scan.co.uk	Issue 149, p92	£57
	8GB Corsair 2133MHz Vengeance LP DDR3 (CML8GX3M2A2133C11B)	www.scan.co.uk	Issue 149, p92	£46
	Noctua L9i	www.scan.co.uk	Issue 149, p93	£33
	Samsung SN-208FB	www.scan.co.uk	Issue 149, p93	£13
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£52
	Crucial 250GB BX100	www.ebuyer.com	Issue 144, p84	£68
	Logitech K400 Plus	www.dabs.com	Issue 149, p93	£31
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£88
			TOTAL	£594



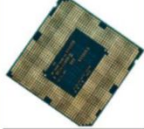







Z97 SERIES MOTHERBOARDS
OVER 500 AWARDS



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Build a budget gaming PC

The parts you'll need to build a budget machine capable of playing the latest games at maximum settings on a 1080p monitor, and even some games at 2,560 x 1,440. The machine has a discrete graphics card, a highly overclockable dual-core CPU and high-speed memory. Meanwhile, the Z97 motherboard gives you headroom to upgrade to a faster CPU later.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	NZXT S340	www.overclockers.co.uk	Issue 137, p54	£60
	ASRock Z97 Pro3	www.scan.co.uk	Issue 130, p50	£72
	Intel Pentium G3258	www.scan.co.uk	Issue 132, p17	£53
	8GB Corsair Vengeance Pro 2400MHz DDR3 (CMY8GX3M2A2400C11R)	www.scan.co.uk	Issue 132, p22	£41
	Asus Radeon R9 380 Strix 2GB UPDATED	www.dabs.co.uk	Issue 150, p48	£160
	250GB Crucial BX100	www.ebuyer.com	Issue 144, p84	£68
	SilverStone Argon AR01	www.scan.co.uk	Issue 132, p57	£26
	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£65
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£52
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£88
			TOTAL	£685

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MOST AWARD-WINNING MOTHERBOARDS













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Build a mid-range PC

Work PC

The parts you'll need to build a solid quad-core PC with plenty of upgrade potential. This kit list gives you an all-in-one liquid cooler and a K-series Core i5 Skylake CPU, meaning you can overclock it and get some serious processing power. We've managed to get the Core i5-6600K Skylake CPU up to 4.6GHz, so it has some great performance potential. Also included is a solid EVGA PSU, a 500GB SSD and 8GB of high-speed DDR4 memory. The core configuration assumes you won't be doing any serious gaming, however, and it relies on Intel's integrated graphics.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	NZXT Phantom 530	www.overclockers.co.uk	Issue 127, p44	£98
	Asus Maximus VIII Ranger	www.scan.co.uk	Issue 147, p44	£140
	Intel Core i5-6600K	www.scan.co.uk	Issue 145, p17	£192
	8GB Corsair Vengeance LPX 2666MHz DDR4 (CMK8GX4M2A2666C16)	www.scan.co.uk	Issue 145, p24	£47
	NZXT Kraken X41	www.overclockers.co.uk	Issue 138, p57	£80
	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£65
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£52
	Lite-On IHAS124-14	www.dabs.com	Issue 99, p108	£10
	Crucial BX100 500GB	www.ebuyer.com	Issue 141, p43	£128
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£88
			TOTAL	£900

Gaming PC

The graphics card you'll need to play current games at their maximum settings at 1080p and 2,560 x 1,440.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	1,920 x 1,080 Asus Radeon R9 380 Strix 2GB UPDATED	www.dabs.co.uk	Issue 150, p48	£160
	2,560 x 1,440 Asus Strix GTX 970 UPDATED	www.amazon.co.uk	Issue 150, p39	£260

Z170 PRO GAMING MOTHERBOARD
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






OVERCLOCK YOUR WAY | GAMING-OPTIMISED FEATURES
BUILT FOR DURABILITY



Build a performance PC

Work PC

The parts you'll need to build a high-quality, fast PC that's ideal for multi-threaded workloads. This kit list features a high-quality, well-built case, a feature-rich motherboard and an Intel Skylake Core i7-6700K CPU. This processor's support for Hyper-Threading splits the resources of the CPU's four physical cores into a further four virtual cores, meaning it can effectively handle eight threads at once. There's also a solid Corsair 750W PSU, giving you plenty of headroom for overclocking and adding another GPU, 16GB of DDR4 memory, a high-speed M.2 SSD and an all-in-one liquid cooler.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Cooler Master Cosmos SE	www.cclonline.com	Issue 144, p41	£137
	Asus Maximus VIII Hero	www.overclockers.co.uk	Issue 146, p20	£170
	Intel Core i7-6700K	www.scan.co.uk	Issue 145, p17	£329
	16GB Corsair Vengeance LPX 2666MHz DDR4 (CMK16GX4M2A2666C16)	www.scan.co.uk	Issue 145, p24	£84
	NZXT Kraken X41	www.overclockers.co.uk	Issue 138, p57	£80
	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£104
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£52
	Samsung SSD 950 Pro 256GB	www.ebuyer.com	Issue 149, p48	£147
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£88
			TOTAL	£1,191

Gaming PC

The graphics card you'll need to play current games at their maximum settings at 2,560 x 1,440 and beyond.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	2,560 x 1,440 Asus Strix GTX 970 UPDATED	www.amazon.co.uk	Issue 150, p39	£260
	4K 2 x Nvidia GeForce GTX 970 4GB	www.amazon.co.uk	Issue 140, p50	£520

Z170 SERIES MOTHERBOARDS
UPGRADE TO INTEL 6TH GEN














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Build a high-end 6-core PC


Multi-threaded PC

The parts you'll need to build a PC with serious power in multi-threaded software, such as 3D rendering apps, video editing programs and optimised distributed computing software. The kit list features a 6-core LGA2011-v3 CPU, which is overclockable using the motherboard and top-end cooler listed. Also supplied is 16GB of RAM, a super-fast M.2 SSD, 1TB of extra solid state storage and a 1.2kW PSU, providing loads of headroom for adding multiple GPUs.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Phanteks Enthoo Luxe	www.eclipsecomputers.com	Issue 144, p53	£117
	Asus X99 Deluxe	www.overclockers.co.uk	Issue 136, p20	£315
	Intel Core i7-5820K	www.scan.co.uk	Issue 134, p43	£311
	Asus Radeon R9 380 Strix 2GB	www.dabs.co.uk	Issue 150, p48	£160
	16GB Corsair Vengeance LPX 2666MHz DDR4 (CMK16GX4M4A2666C16)	www.scan.co.uk	Issue 136, p14	£94
	EKWB EK-Predator 240	www.scan.co.uk	Issue 148, p30	£160
	Corsair Professional Series AX1200i	www.scan.co.uk	Issue 111, p40	£260
	Samsung SSD 950 Pro 512GB	www.dabs.com	Issue 149, p48	£261
	Samsung 850 Evo 1TB	www.cclonline.com	Issue 141, p51	£259
	Lite-On IHAS124-14	www.dabs.com	Issue 99, p108	£10
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£88
			TOTAL	£2,035

4K gaming PC

This LGA2011-v3 system can support multiple graphics cards over 28 PCI-E 3 lanes, making it an ideal foundation for high-resolution PC gaming, replacing the graphics card listed above with two high-spec cards.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	4K 2 x Nvidia GeForce GTX 970 4GB	www.amazon.co.uk	Issue 140, p50	£520
			TOTAL	£2,395



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Build a mini PC

Core components

The parts you'll need to build either PC. This kit list gives you a solid PSU, 16GB of RAM, an overclockable Skylake CPU, an all-in-one liquid cooler and Windows 10 Home 64-bit. Also included is a short-PCB graphics card that can play current games at their maximum settings at 2,560 x 1,440, and a high-speed 256GB M.2 SSD.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Intel Core i7-6700K	www.scan.co.uk	Issue 147, p84	£329
	16GB (2 x 8GB) Corsair Vengeance LPX 2666MHz	www.scan.co.uk	Issue 147, p84	£84
	Corsair H80i GT	www.scan.co.uk	Issue 147, p84	£80
	Asus GeForce GTX 970 DirectCU Mini	www.cclonline.com	Issue 150, p38	£255
	Samsung SSD 950 Pro 256GB	www.ebuyer.com	Issue 149, p48	£147
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£52
	Lite-On IHAS124-14	www.dabs.com	Issue 99, p108	£10
	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£65
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£88

Mini-ITX PC

The parts you'll need to build a pint-sized powerhouse.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Corsair Obsidian 250D	www.scan.co.uk	Issue 136, p41	£75
	Asus Z170i Pro Gaming	www.cclonline.com	Issue 147, p26	£104
			TOTAL	£1,289

Micro-ATX PC

The parts you'll need to build a mini PC that doesn't take up as much room as a full-sized desktop.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Fractal Design Arc Mini R2	www.scan.co.uk	Issue 127, p46	£67
	Asus Maximus VIII Gene	www.eclipsecomputers.com	Issue 147, p42	£168
			TOTAL	£1,345

Strix gaming series











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Cases

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Budget ATX	NZXT S340	www.overclockers.co.uk	Issue 137, p54	£60
	Sub-£100 ATX quiet	Fractal Design Define R5	www.scan.co.uk	Issue 137, p20	£80
	Sub-£100 ATX performance	NZXT Phantom 530	www.overclockers.co.uk	Issue 127, p44	£98
	Sub-£150 full-sized ATX quiet	Nanoxia Deep Silence 5	www.quietpc.com	Issue 144, p50	£113
	Sub-£150 full-sized ATX	Phanteks Enthoo Luxe	www.eclipsecomputers.com	Issue 144, p53	£117
	Sub-£150 mid-size ATX	Cooler Master Cosmos SE	www.cclonline.com	Issue 144, p41	£137
	Mini-ITX tower	Corsair Obsidian 250D	www.scan.co.uk	Issue 136, p41	£75
	Mini-ITX cube	Fractal Core 500 UPDATED	www.ebuyer.co.uk	Issue 150, p20	£40
	Micro-ATX	Fractal Design Arc Mini R2	www.scan.co.uk	Issue 127, p46	£67
	Water-cooling micro-ATX	Parvum Systems S2.0	www.overclockers.co.uk	Issue 129, p22	£140

Graphics cards

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	1,920 x 1,080 gaming	Asus Radeon R9 380 Strix 2GB UPDATED	www.dabs.co.uk	Issue 150, p48	£160
	2,560 x 1,440 gaming	Asus Strix GTX 970 UPDATED	www.amazon.co.uk	Issue 150, p39	£260
	High-end single-GPU gaming	EVGA GeForce GTX 980 Ti Classified ACX 2.0+	www.scan.co.uk	Issue 147, p24	£570
	4K gaming	2 x Nvidia GeForce GTX 970 4GB	www.amazon.co.uk	Issue 140, p49	£520
	Mini-ITX	Asus GeForce GTX 970 DirectCU Mini	www.cclonline.com	Issue 150, p38	£255

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ASUS STRIX R9 FURY



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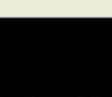
Power supplies

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Mid-range 550W	EVGA SuperNova GS 550W	www.scan.co.uk	Issue 146, p50	£65
	High-end 550W	Super Flower Leadex Platinum 550W	www.overclockers.co.uk	Issue 146, p52	£80
	Mid-range 750W	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£104
	High-end 1.2kW	Corsair Professional Series AX1200i	www.scan.co.uk	Issue 111, p40	£260

Networking

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Router	Asus RT-AC68U	www.scan.co.uk	Issue 128, p88	£138
	Wi-Fi adaptor	Asus PCE-AC68	www.scan.co.uk	Issue 128, p88	£65

Storage







	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Hard disk	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£52
	250GB SSD	Crucial BX100 250GB	www.ebuyer.com	Issue 141, p43	£68
	500GB SSD	Crucial BX100 500GB	www.ebuyer.com	Issue 141, p43	£128
	1TB SSD	Samsung 850 Evo 1TB	www.cclonline.com	Issue 141, p51	£259
	High-performance SSD	Samsung SSD 950 Pro 512GB	www.dabs.com	Issue 149, p48	£261
	NAS box	Synology DS215J	www.cclonline.com	Issue 138, p17	£134

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Monitors

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	24in monitor	Dell U2414H	www.overclockers.co.uk	Issue 129, p43	£189
	29in monitor	Asus PB298Q	www.scan.co.uk	Issue 129, p52	£269
	28in 4K monitor	Asus PB287Q	www.scan.co.uk	Issue 133, p44	£378
	G-Sync monitor	Asus ROG Swift PG278Q	www.eclipsecomputers.com	Issue 143, p44	£552
	FreeSync monitor	BenQ XL2730Z	www.overclockers.co.uk	Issue 143, p46	£456
	4K G-Sync monitor	Asus ROG Swift PG27AQ	www.scan.co.uk	Issue 149, p24	£779

Peripherals






	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Mechanical gaming keyboard	CM Storm Trigger-Z	www.eclipsecomputers.com	Issue 139, p44	£95
	Budget gaming mouse	Cooler Master Xornet II	www.cclonline.com	Issue 149, p28	£21
	Gaming mouse	Logitech G402 Hyperion Fury	www.currys.co.uk	Issue 139, p53	£40
	Ambidextrous mouse	Roccat Kova UPDATED	www.cclonline.com	Issue 150, p28	£50
	MMO gaming mouse	Corsair Scimitar RGB UPDATED	www.scan.co.uk	Issue 150, p17	£70
	Wireless gaming mouse	SteelSeries Sensei Wireless	www.overclockers.co.uk	Issue 139, p61	£100
	Flight stick	Saitek X-55 Rhino H.O.T.A.S.	www.overclockers.co.uk	Issue 131, p29	£170
	Steering wheel and pedals	Thrustmaster TX Ferrari 458 Italia Edition	www.overclockers.co.uk	Issue 137, p32	£300

No.1
Gaming Monitor Brand











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Audio

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	PCI-E sound card	Asus Strix Raid DLX	www.cclonline.com	Issue 148, p28	£141
	2.1 speakers	Acoustic Energy Aego M	www.amazon.co.uk	Issue 142, p52	£150
	Soundbar	Razer Leviathan	www.overclockers.co.uk	Issue 142, p57	£165
	Headset	HyperX Cloud II	www.scan.co.uk	Issue 142, p46	£69
	Surround-sound headset	Asus Strix 7.1	www.saverstore.com	Issue 142, p43	£127

Systems

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Quiet gaming PC	Chillblast Fusion Serenity	www.chillblast.co.uk	Issue 138, p66	c. £1,499
	Dream PC	Scan 3XS Barracuda	www.scan.co.uk	Issue 145, p58	c.£9,499
	Sub-£2,000 gaming PC	CyberPower Infinity X77 Deluxe UPDATED	www.cyberpower.system.co.uk	Issue 150, p56	£1,999
	Skylake PC	Scan 3XS Z170 Vengeance	www.scan.co.uk	Issue 145, p66	c. £1,449
	Mini-ITX gaming PC	Chillblast Fusion Fury Nano	www.chillblast.co.uk	Issue 147, p56	c.£1,619
	Gaming laptop	MSI GT70 2PC Dominator	www.overclockers.co.uk	Issue 129, p26	c. £1,320
	Premium PC	Scan 3XS X99 Carbon Extreme SLI	www.scan.co.uk	Issue 148, p62	c.£4,799
	Water-cooled PC	Overclockers Infin8 Toxicity UPDATED	www.overclockers.co.uk	Issue 150, p58	£3,414

STRIX R9 390X | R9 390 GAMING GRAPHICS CARDS
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Games



Featured this month

Inverse look p73 / Just Cause 3 p74 / Rainbow Six: Siege p76 /
Game of Thrones: A Telltale Game Series: Season One p76 / Dirt Rally p78 /
The engine room – RAGE / The Pinnacle of V p80 / Games of 2016 p82



RICK LANE / INVERSE LOOK

VIDEO NASTIES

YouTube commentators could be confronting game publishers, but instead, they're often enthralled by their marketing teams, argues Rick Lane

At lunchtime I like to watch short, informative videos on YouTube. My current favourite series is a fast-paced science show called Crash Course Astronomy, recommended to me by our very own Tracy King. It was before watching the latest episode of CCA that an advert played that almost caused me to fall out of my chair.

The advert was for Ubisoft's tactical multiplayer shooter Rainbow Six: Siege. In it, several gaming YouTubers – video producers who specialise in game coverage that straddles the line between entertainment and criticism – were taken on a Rainbow Six-themed paintballing assault course, led by writer and ex-SAS specialist Chris Ryan.

Many gaming video producers are paid by developers and publishers to cover their products. Some choose to disclose this information, while others don't. Some work to publisher-specific restrictions about what they can and can't say about the game in their videos, while others don't. But the notion of YouTubers accepting money in exchange for coverage is now so common that it's rarely challenged.

But the Rainbow Six advert takes this relationship to another level. The three YouTubers weren't simply being paid to cover the game, they were being used to advertise it. Not only that, but they were also being used to advertise it in a scenario where the actual game barely features.

If it had been me, or another writing-focused journalist or critic who had featured in this advert, we would have been hounded by corruption allegations, and such a response would be unjustified. But YouTubers appear to be immune to allegations of corruption through the guise that what they produce is 'coverage' rather than 'criticism'.

You can't honestly criticise a work you've been paid to examine by its creators

I find this distinction spurious. If you're offering opinions on a creative work to an audience, you're engaging in criticism, and while criticism is subjective, you can't honestly criticise a work you've been paid to examine by its creators.

The YouTubers are at least fairly open about it. All three have the advert posted on their YouTube channels, and mark it as an advert in the description, albeit below the 'Show more' line rather than above it. Hopefully, they'll be transparent about their participation in marketing for the game in future coverage of it too, or ideally not cover it at all.

Frankly, though, the problem isn't so much the relationship between marketers and YouTubers, however deeply uncomfortable I find it as a critic. The main issue is how YouTubers are then perceived by their audience. There's a general consensus among young gaming audiences that YouTubers represent a grassroots alternative to the established gaming media that's long been the target of (mostly unfounded) allegations of corruption from its readers. Yet

these same individuals often see no issue with YouTube commentators taking work from a game's marketers and later discussing the game in their videos. Established journalism is seen as corrupt, but YouTube commentators are considered the voice of the people, and hence can act as they please without ramifications from their audience.

The real tragedy is that YouTube commentators have the power through their substantial followings to cover these games entirely on their own terms, to step away from the marketing microphones of larger publishers and provide an entirely standalone perspective. Instead, they happily accept the position of marketing mouthpieces. **GPU**

Rick Lane is Custom PC's games editor. [@Rick_Lane](#)



Just Cause 3 / £39.99 inc VAT

DEVELOPER Avalanche Studios / PUBLISHER Square Enix / WEBSITE <http://justcause.com>



Where most open-world games would spend an hour or two setting up a half-baked drama about a gruff vigilante who must destroy an entire city in order to avenge their son, wife or dog, JC3 commences with you shooting rockets while standing on the wing of an aeroplane. It knows what it wants to deliver – namely lots of huge explosions – and it isn't going to let inconveniences such as plot coherence or character depth get in the way.

Instead, JC3 brings more of the madcap action of its five-year-old predecessor. There are more settlements to liberate, more gadgets and, most importantly of all, more stuff to blow up. Unfortunately, while plenty has been added, not an awful lot has changed, and a fair amount of what *has* changed sadly hasn't changed for the better.

As with previous Just Cause games, JC3 sees professional dictator remover Rico Rodriguez parachuted into a beautiful archipelago whose inhabitants are being slowly crushed

beneath the thumb of a corrupt despot. This time, the setting is the idyllic Mediterranean island-chain of Medici, a vast and varied environment where sunflower fields and beautiful continental villages sit within miles of sprawling military bases on top of towering, snow-dusted mountains.

There's a story, which sees Rico teaming up with a gang of island rebels, reuniting with friends old and new on the island that was once his home, but it mainly acts to suggest a route through the game. There's little in the way of sentimentality or narrative drama; it's more a sequence of jokey cutscenes that loosely connect fairly typical examples of open world missions. Drive the car here; shoot the people there; destroy the thing in here.

However, the game's main attraction is the ability to freely cause havoc wherever you want, however you want, and Rico has an impressive array of weapons and gadgets at his disposal. The parachute and grappling-hook combo returns from JC2 and, alongside the newly introduced wingsuit, ensures that getting from place to place is as fast as it is thrilling. The airborne methods of travel, grappling to build speed, opening the parachute to gain height and then deploying the wingsuit for distance, are so enjoyable that cars are reduced to an occasional novelty, while tanks, helicopters and jets become throwaway power-ups used mainly for destruction.

Travelling at altitude also provides a generous vantage point from which to spot areas of interest. They're mainly divided between towns that require liberating and military encampments that need obliterating. Assuming control of either requires destroying anything coloured red in the area, alongside a few activities such as taking control of police stations.

Liberating towns is enjoyable, but the fun really lies in the military bases. Some of the destructible objects are huge, such as towering radar spires and massive satellite dishes that crumble to the ground in 100 pieces when destroyed. When it comes to method, almost anything goes. Rocket launchers are merely the baseline; greater destructive opportunities lie in stealing tanks and helicopters, turning anti-aircraft guns on the enemy, or dropping some of Rico's unlimited supply of C4 explosives from hundreds of feet in the air. Rico's grappling hook can be used to tether objects together and then reel them in towards one another, which is particularly handy for tearing down statues, or dragging environmental explosives towards distant objects.

The main attraction
is the ability to
freely cause havoc
wherever you want

OVERALL SCORE

70%

/ VERDICT

Just Cause 3 takes two steps forwards and one step back, but it remains an entertaining crash course in anarchy.



While the action makes for a satisfying visual feast, though, systematically Just Cause 3 carries over some irksome problems from JC2. Rico feels tremendously powerful in the air, but he's noticeably more limited on the ground. The shooting is rather rudimentary, with most enemies waiting to receive Rico's bullets like a blessing, while the movement controls are annoyingly sluggish. The game is crying out for a dodge mechanic to spice up the earthier action. A few items are actually less useful than before too. Unless he's in the air, Rico has to manually place C4 explosives on objects rather than throw them, an action which, in the thick of battle, is clumsy and leaves him exposed to enemy gunfire.

JC2's Chaos system, through which **you unlocked** missions by causing general anarchy, **has also taken a** step back in favour of the liberation mechanic. **That's fine** for a while, but having to find every destructible object in an area before it's considered 'liberated' **eventually turns the** creative fun into busywork. We hesitate **to call it tedious, but** it definitely loses some of the appeal.

More problematic is the fact that **many of the** most interesting upgrades, such as the wonderfully ridiculous rocket-boosted explosives, can only be unlocked by completing 'challenges', the lowest order of the game's activities. Some challenges are fairly entertaining, such as the 'car bomb' events, in which you must drive **an** explosives-laden vehicle above a certain speed toward an objective, but many involve destroying the same objects in **an area** you've just liberated, albeit using a **specific weapon**. It would make more sense for these upgrades **to be** attached to the Chaos system, and have **them unlock** gradually for acting out the game's action-hero fantasies.

Just Cause 3 is also a bit of a performance monster. At the higher settings, it struggles to render complex scenes smoothly, even on our GeForce GTX Titan test card.

Yet the biggest technical issue we encountered was due to Square Enix's asinine decision to have the game constantly seek out an Internet connection whenever an in-game menu is loaded. At its worst, this system resulted in the game freezing for a minute each time we wanted to look at the map, which happens a lot in a virtual world as large as Medici.

Still, it's difficult to deny Just Cause 3's essential sense of fun. It isn't a massive leap forward from JC2, and in some areas, it's a slight step back. But it's still a game in **which you can derail a freight train by crashing a helicopter into a bridge, which means Rico Rodriguez still has a place in our hearts.**

RICK LANE



Rainbow Six: Siege / £50 inc VAT

DEVELOPER Ubisoft / PUBLISHER Ubisoft / WEBSITE <http://rainbow6.ubi.com/siege>



OVERALL SCORE
80%

/ VERDICT

Rainbow Six: Siege requires specific circumstances to get the most out of it, but when things come together, it's a gaming highlight of the year.

Rainbow Six: Siege is a multiplayer-focused tactical shooter in which a squad of five counterterrorists (CTs) must infiltrate a building, which is fortified against attack by a group of terrorists, then eliminate the threat by combining delicate teamwork with explosive force. It's a superb premise, but Siege becomes special when both teams work closely to outmanoeuvre the other.

A round of Siege's multiplayer game is split into two phases. In the first phase, the CTs must attempt to locate their target within the building, be it a hostage that needs rescuing or a bomb that requires defusing. Meanwhile, the terrorists have around a minute to establish a defence, barricading doors with wooden slats, reinforcing walls using metal panels and laying booby traps such as trip mines and C4 explosives.

Then the execution phase begins. The CTs move through the building, feeling out a plan of attack, while the defenders wait in nervous silence for the walls to start exploding around them. One of Siege's standout features is its highly destructible environments. It's possible to blast a hole in a surface and then use it to shoot encroaching enemies, while other surfaces can be destroyed entirely to create a makeshift entry point.



As a result, attack can come from anywhere in a game where the environment design is already deliberately complex. Whether it's a hotel or a farmhouse, each building is a deadly maze of clutter-filled rooms and blind corners. Almost anywhere can become an ambush point and nowhere is guaranteed to be safe. Proceeding through these spaces requires caution, checking angles and minimising your exposure to enemy fire wherever possible.

When both teams coordinate properly, Siege is fantastic. Organising a tactical insertion as an attacker, identifying enemy positions before breaching the appropriate room from multiple angles and ending the round in a swift spray

Game of Thrones: A Telltale Game Series: Season One / £22.99 inc VAT

DEVELOPER Telltale Games / PUBLISHER Telltale Games / WEBSITE www.telltalegames.com/gameofthrones



OVERALL SCORE
80%

/ VERDICT

Telltale's narrative style proves a fine fit for the Game of Thrones universe, although more flexibility in both choices and play wouldn't go amiss.

George R.R. Martin's Song of Ice and Fire series takes place in a hugely detailed fantasy realm with complex and delicately interwoven lore, so telling a new story in that world, with its constant popping up and popping off of characters, is no mean feat. As such, Telltale deserves credit for creating a new story that not only squeezes itself carefully within the established fiction, but also enhances its main threads. Like any success in Westeros, though, it comes with a price.



Telltale's Game of Thrones centres on the newly introduced House Forrester, as the family struggles to defend its holdfast of Ironrath and its precious Ironwood trees from the grasping hands of rival houses, which have risen to prominence in the wake of the Red Wedding. It's a task that requires the aid of every family member, including a daughter in the service of Queen Margery at King's Landing, and an exiled son fighting as a Mercenary in the far-flung deserts of Essos.





of bullets is a rewarding experience. Unless you can get ten friends together, however, your experience will be rather less transcendent. Playing Siege with random Internet folk is still largely enjoyable, but victory more often comes down to who has the fastest trigger finger or the best character abilities (riot shields in particular offer a huge defensive advantage).

While multiplayer is overwhelmingly the focus, there's also a single-player offering in the form of Situations, a rather hastily cobbled together tutorial campaign that takes you through the game's basic systems. Meanwhile, Terrorist Hunt mode can be played either alone or

cooperatively, and involves **squaring off against a large number of armed vigilantes in a given location.** Both modes are enjoyable, **but a proper campaign with AI controlled teammates** would have elevated the game into classic territory.

As it stands, Siege is a fine tactical shooter that can, **in the right circumstances, be superb. It's expensive, but it's** ideal for anyone who has **exhausted the tactical** play of games such as Irrational's classic **SWAT 4.**

RICK LANE



Telltale quickly proves adept at handling Game of Thrones' narrative style and tone, establishing empathetic characters and powerful relationships with relatively few lines of dialogue. This, of course, makes it all the more gut-wrenching when the game brutally cuts them down. Don't let the subtly cartoon shades of the game fool you either; Telltale's representation of Westeros is as brutal and shocking as that of the TV show.

The effect of the game's dramatic twists is compounded by how their consequences link to decisions you make during play. There are points in the series where characters live or die depending on your actions. More often than not, however, choices are cosmetic, often only changing a line of dialogue or simply forcing the game to take a detour to the same destination. This situation doesn't alter the impact the choices have on the player at the time, and that's ultimately

what counts, but sometimes you can almost see the game steering back to its original course, and that's a problem.

There's little interaction too. You can rarely explore locations on your own terms, and there are a few instances where the game hands you the controls long enough to walk down a corridor before snatching them back like an impatient sibling. Also, while the art style is pleasant and occasionally beautiful, the lack of rendering capability means the game frequently feels cramped and confined, lacking the grander, more opulent feel of the TV show.

Still, as a companion to the books and TV series, Telltale's Game of Thrones stands equal in terms of characterisation and bloodthirsty politicking. Plus, it does so in a way that gives you some control over how events proceed, although it falls short of Telltale's best work in The Walking Dead.

RICK LANE





Dirt Rally / £29.99 inc VAT



DEVELOPER Codemasters / PUBLISHER Codemasters / WEBSITE www.codemasters.com/game/dirt-rally



Dirt Rally is a racing simulation so brutal and uncompromising it could reasonably be classified as a horror game. The line between speed and control must be navigated with the balance of a mountain goat if you want to avoid turning your car into sponsorship-branded scrap.

The bodywork of Dirt Rally will be familiar to any racing fan, framed largely around a career mode that involves working your way up a series of rally championships, unlocking better cars and more difficult race types as you progress. Unlike previous Dirt games, however, Dirt Rally is focused entirely on rallying experience, and refuses to accommodate many of the safety nets that crept into previous Dirt games. The flashback ability that let you rewind a race to undo mistakes has been jettisoned, for example. Likewise, restarting a stage eats into your overall winnings, and retiring will disqualify you from the entire event in which you're participating.

Dirt Rally wants you to respect the courses and the persistence required to complete them, and you can see why. Dirt Rally's globetrotting events feature some of the most fiendishly designed driving challenges ever. They range from the winter blunderland of

Sweden, where the road is a thin strip of packed snow between two deep drifts that slows cars to a crawl, to the foreboding Welsh countryside, where sheer drops and sharp turns hide behind undulating moorland. Passing any of these rigorous rallying exams demands your absolute attention and requires perfectly attuned driving skills.

Driving is no mean feat either, as the vehicles offer vastly diverse handling. The initial 1960s cars, the Mini Cooper and Lancia Fulvia, move like bricks on ice, building momentum gradually and gliding heavily through corners. By comparison, the 1980s and 1990s cars are very fast in a straight line, but unpredictable in a corner. Each vehicle is further differentiated by how you tune it for a particular stage. You can fiddle with every aspect, from gearing and suspension to damping, affecting traction, cornering, straight-line speed and a half a dozen other factors.

The challenge and pinpoint detail is refreshing and rewarding, but it may be offputting to players who have become accustomed to recent more forgiving racers. Codemasters does little to educate you in Dirt Rally's new ways too. There's no driving tutorial and only the most rudimentary tuning hints. What's more, the alternative race modes, namely rallycross and hillclimb, are locked off until you've purchased a car that can compete in them. The game requires significant input before completely opening up, verging on the dread word 'grind'.

Fortunately, Dirt Rally's core racing is as gripping as it is difficult, and when you finally grapple your way to your first stage win, you'll know you've truly earned it.

RICK LANE

OVERALL SCORE

86%

/ VERDICT

Dirt Rally is a truly harsh mistress, but its formidable challenge yields unparalleled thrills.



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RICK LANE / THE ENGINE ROOM

RAGE/The Pinnacle of V

Rick Lane investigates one man's mission to make GTA V's open world look as realistic as possible

Graphics modding has been a huge component of PC gaming culture for years. Many major games, from Skyrim to Starcraft, have an abundance of mods that tweak, enhance and optimise their games' technological components, and some even introduce completely new effects.

One of the most striking recent graphical mods is the Pinnacle of V. A comprehensive visual and mechanical update for Grand Theft Auto V, the Pinnacle of V was created to push GTA V as close as possible to realism. It alters and enhances almost every aspect of Rockstar's open-world game. The Pinnacle of V was created by Josh Romito, a first-time modder who was inspired by the modding community's work on enhancing the previous Grand Theft Auto game. 'Originally, my work began as something personal. I later decided to put it out to the community, and the feedback was amazing, pushing me to dig deeper and deeper,' Romito says.

For anyone wanting to delve into the code of Rockstar's incredible RAGE (Rockstar Advanced Game Engine) tech, there's an immediate obstacle – Grand Theft Auto V has no modding support. Nevertheless, a modding community has evolved around GTA V, and it all comes courtesy of a third-party tool named Open IV. Created by modders in Russia, Open IV is the same tool that Romito used to begin work on The Pinnacle of V.

'This program is what allows users to access the .rpf files, and extract



The mod looks stunningly convincing in the rain



Romito introduced his own 4K textures for plants in the game

and import our modifications,' Romito explains. 'There's still a large portion of files that are encrypted, which we can't access yet – mainly .ymt files that control the deeper tuning elements of the game. Some of these files have been found in the Xbox 360 version, unencrypted as .meta files, but simply changing the file extension to "ymt" allows perfect compatibility with the PC version.'

Romito spent around a month simply learning his way around the

interior of RAGE. He describes the experience as 'like sitting in the cockpit of a fighter jet for the first time, looking down at all the unknown controls, and thinking: "I'm going to fly this thing!"'

Romito's self-tutoring of how to harness RAGE's power provides fascinating insight into how the engine functions. He cites the dynamic weather system as one of the engine's most powerful features, as it gives developers complete control over the lighting, colour and intensity of the rendered image, with sub-files for location-specific weather and lighting effects across GTA V's vast open world.

'This alone enables for lots of customisation to the game's visuals, and it's where I spent a large amount of my time editing,' Romito says. He also notes that RAGE allows similar levels of control for many



The textures of buildings aren't 4K, but they look sharper and more vivid, thanks to Romito's lighting adjustments

from photos I took myself. I went out for a walk, found some nice green leaves, laid them down on a black sheet and snapped a few 4K photos.' These images were then edited and colour-adjusted in Photoshop, before Romito painstakingly laid them over the original textures. Romito highlights the retexturing as the most time-consuming process in the entire mod's development.

Perhaps Romito's most interesting discovery during his time beneath RAGE's skin was how to alter NPC relationships, and hence the player's

experience. 'This was actually simpler than I thought,' he says. 'I stumbled upon a file called 'relationships.dat', which provided a breakdown of the relationship status between different model sets.' Essentially, relationships between different 'groups' of NPCs are broken down into emotional

parameters, such as 'hate' or 'respect', and tweaking these parameters effects the AI character's behaviour.

Romito's main alterations were intended to increase the chances of lively encounters between NPC police and NPC criminals, although he also made some more personal changes. 'I started by removing the ability for dogs to attack you,' he says, lamenting the fact that you're often forced to kill animals in the game.

GTA V was created by a team of hundreds of people, the Pinnacle of V by just one. It's a mod that demonstrates the impact an individual can have on a game with determination and the right kind of access – Romito estimates that he's spent around 2,000 hours designing the mod. But it also highlights the flexibility that Rockstar has built into its tech, given that the only fundamental *additions* Romito made to it were the 4K textures. RAGE would be an enormously powerful toolkit if Rockstar made modding support official, but until that happens (if ever), we'll have to rely on the ingenuity of people such as Romito to push games beyond the developers' intentions. **GPR**

aspects of the game beyond visuals, such as vehicle handling. 'I felt like I was tuning real vehicles, you can adjust the weight, suspension, drive inertia, gear changes, fuel, oil, damage deformation, collision, turn radius and so on – the list goes on...'

While some areas of RAGE enable an incredible amount of flexibility, its file encryption means certain areas of the engine are simply inaccessible, the main one being shaders. This restriction prevented Romito from addressing some of RAGE's more obvious shortcomings. Puddle and environment reflections, for example, don't reflect dynamic objects (traffic, pedestrians and so on). 'A rainy night with a street full of vehicles is a wonderful sight, until you look into the reflections and realise that not a single dynamic object is being displayed,' Romito says. 'I understand that it probably came down to a choice of performance over visuals, but it totally destroys immersion.'

Nevertheless, Romito set about altering the areas he could access, tweaking the colour balance for a more realistic look, improving clouds, wind, rain and other weather effects, and enabling shadows on smoke and particle effects. Not all of the process was about addition or improvement either. He actually removed some effects, particularly ones that simulate a camera lens, such as lens flare, chromatic aberration and film grain.

Gradually, Romito's method shifted from simply changing parameters in the engine code to



adopting a more physically-based approach. He describes his method for improving rainwater puddles in the game. 'I spent a lot of time outside in the real world, where I remember sitting and staring at puddles when raindrops hit them, watching and timing the speed at which the ripples expanded, noting how large they became and how quickly they dispersed. After the proper files were found, I decided that I would apply my mental notes to the data.'

Eventually, Romito began adding assets of his own, developing a 4K texture pack to complement his effect enhancements. He created some of these textures specifically for this purpose. 'A few of the plant textures I made were textures ripped

Reflections have been improved considerably, but dynamic reflections are still beyond the mod's capabilities

A big component of the mod's push towards realism involved the removal of camera artefacts such as lens flare and chromatic aberration



Games of 2016

Rick Lane runs down the gaming highlights due in the next 12 months



JANUARY

The Witness

The year of 2016 kicks off with the release of Jonathan Blow's long-anticipated follow-up to 2008 platformer Braid. The Witness is a puzzle game inspired by the 1990s adventure Myst. It drops the player onto a picturesque island divided into ten sections that surround a mountain, and the ultimate goal of the game is to reach this mountain's summit.

Each section contains a wide variety of maze-type puzzles. However, the rules for completing each maze differ each time and are communicated with varying degrees of clarity. Any given section will have a theme that acts as a clue to solving every maze in that section. Some mazes simply require you to find a route through them, while others require you to trace a specific path. Some mazes contain clues to solving other puzzles within their solution, and these clues can be explicitly or implicitly delivered.

There are 650 puzzles in all, although only a handful of them need to be completed in order to reach the mountain summit. Blow has stated that the significance of The Witness lies not within the puzzles themselves, but how each puzzle interlinks and contributes to the game's overarching narrative. It's a fascinating project, and one we look forward to exploring after such a lengthy gestation.



APRIL

Total War: Warhammer

For the first time, Total War is abandoning history, with its spectacular large-scale battles soon to be pitched in the fantasy fields of the Warhammer world. It's an exciting prospect, as it allows The Creative Assembly more creativity in terms of unit types. Greenskin armies can field massively powerful units such as Giants, Trolls and Arachnarok spiders, while the Empire can counter with mechanised armour units and fearsome artillery barrages. Warhammer also introduces flying units such as dragons, and the ability to use devastating magic spells, to Total War.

There will also be a new Quest mode, which gives a directed, mission-based path through the game as an alternative to the old sprawling campaigns, while Hero and Agent units now have a physical presence on the battlefield, boosting morale in the armies they lead or support.

Of course, Total War's battles play out in real time, so the turn-based rules of traditional Warhammer won't be much use either. It's also important that The Creative Assembly balances the armies and units fairly, as Total War's reputation has taken a beating of late. The previous game, Rome II, was a bit of a mess upon release, so let's hope Warhammer's spectacle is equalled by its sharpness.



MAY

Mirror's Edge: Catalyst

The original Mirror's Edge had a fantastic premise, but even its most ardent fans would agree that its thrilling, free-running concept was held back by its rigidly linear nature. Seven years on, EA DICE is finally having a second stab at the idea in the form of Mirror's Edge: Catalyst.

Catalyst aims to make the free-running truly free. It takes place in a fully open world, allowing you to pick your own path across the white and chrome rooftops of DICE's beautiful dystopian Glass City, perhaps the most visually stunning urban environment ever created for a game. The game's hallmark 'runner vision', which guided players as they dashed across rooftops, now adjusts dynamically depending on markers placed by the player on the map, enabling the same kind of movement fluidity depicted in the first game, but also letting you go off the rails if you feel the need.

The original game's rather wonky combat has been overhauled too. Guns can no longer be used by the player. Instead, an expanded retinue of hand-to-hand techniques is on offer, with an emphasis on evasion and speedy takedown moves. The only change that seems a little odd is that the game is a reboot rather than a direct sequel. DICE intends to expand the story behind Faith's origins as a runner, and her attempt to overthrow the corporation that controls the city.



JUNE

No Man's Sky

Hello Games' beautiful space exploration game, No Man's Sky, takes place in a procedurally generated galaxy featuring hundreds of thousands of stars and millions of planets, each with unique flora and fauna conjured by algorithmic wizardry. The amount of detail and variety demonstrated is remarkable. It even has its own periodic table of elements, which can be used to craft equipment or simply sold as raw materials for profit.

However, it's also difficult to tell how this variety translates into fun play. In the most recent footage, No Man's Sky doesn't look far removed from the classic space game formula. You can trade goods in a free-market system, fight with or against various factions that travel in vast interstellar fleets, or simply earn a living by discovering and cataloguing the wide array of procedurally generated plants and animals that populate many of the game's planets. Players can also name any discovery they find, and that information will then be permanently uploaded to the game's Atlas catalogue.

There's a concern that No Man's Sky will end up being a fantastic game in which to wander around, but ultimately not that much fun to play. That said, it could equally be a wondrous gaming experience. It all depends on how those bright colours and impressive numbers translate into an interactive space.

TBA

DooM

Finally, 2016 witnesses the return of the FPS granddaddy. Doom is back, rebooted as DooM. What's more, developer id is planning on going back to the series' roots, or the perceived roots at any rate. The plodding, narrative-focused corridor shooting of Doom 3 has been replaced with fast-paced, hyper-violent corridor shooting, featuring ludicrously powerful guns, brutal melee takedowns and enough gore to make Genghis Khan vomit into his horse milk.

Whether these elements are indeed truer to the original game than Carmack's efforts in Doom 3 or not, DooM certainly looks a darn sight more entertaining than the 2004 sequel. Enemies are lithe and vicious, while weapons are spectacular and ferocious. Let's hope, however, that the developers remember the most important aspect of the original game – the level design. Doom wasn't built as a linear game,



but rather as a series of deadly mazes that the player had to solve with a combination of bullets and navigation techniques.

Either way, DooM is shaping up to be a healthy dollop of good old-fashioned fun, and sometimes that's all a game needs to be. **8/10**



Build a Fallout 4[®] Gaming PC

Want to build a PC to tackle Fallout 4? Antony Leather looks at the hardware you need

If you're finding Fallout 4 to be a tough customer on your current gaming rig, we have just the feature for you this month. In addition to featuring the game in our new graphics card benchmark suite, as used in our GTX 970 and R9 380 group tests (see p36), we've also looked at Fallout 4 GPU performance and fine-tuning its settings (see p90). If you're looking to build a whole new gaming PC, though, then over the next few pages, we'll look at all the gear you need to build a PC to play Fallout 4, as well as all the other latest games.

We'll be taking a look at which graphics card you need to play the game at various resolutions, and discussing the rest of the PC as well – Devil's Canyon vs Skylake for the CPU and making our picks of the best cases, coolers, PSUs and storage.

How many pixels?

As with any game, the key factor in picking your hardware is your monitor's resolution. At the low end, 1,920 x 1,080 is relatively easy to nail, even at maximum graphics settings, but Fallout 4 extracts a heavy toll

for moving from High to Ultra detail. For instance, in our testing this issue, even the lowly Radeon R7 370 and GeForce GTX 950 were able to handle 1080p with minimum frame rates of 35fps and 42fps respectively at High settings. However, raise the stakes and apply the Ultra detail setting and these minimums drop to 25fps and 29fps – the former being only just about playable.

Of course, we don't just want playable frame rates now, but also to provide some headroom for future, more demanding games and possibly also higher resolutions.

If you game at 1,920 x 1,080 now, you may also be thinking of upgrading to a 2,560 x 1,440 screen, or even a 4K display, in the future.

I want to play at 1,920 x 1,080 and don't mind reducing the detail settings a little

TOP PICK: Nvidia GeForce GTX 950 2GB

At high detail, the GTX 950 is the king of budget gaming in Fallout 4. It's faster than the similarly priced R7 370, managed a minimum of 42fps at High detail and even managed 29fps at Ultra detail too. It gets a little stutter at 2,560 x 1,440, though, and only the High detail setting gives you any headroom.

I want to play at 1,920 x 1,080 at Ultra settings and might get a higher-resolution screen in future

TOP PICK: AMD Radeon R9 380 4GB

You'll have to dial down the settings massively with either a GTX 950 or R7 370 if you move to 2,560 x 1,440, which means you'll need to fork out a little more cash. It's a choice between AMD's R9 380 and Nvidia's GTX 960 here, and for the most part, they're not far apart.

However, as the R9 380 can be currently found for around £10-15 less than the GTX 960, and it's generally a little quicker in other games, it gets our vote. That said, if you like your system to be cool and quiet, the GTX 960 is still worth considering over the R9 380 – it generates less heat, most models sport semi-passive coolers and it draws less power too.

There's one final option to consider too – the 2GB and 4GB versions of the R9 380. Fallout 4 makes good use of the 4GB model's extra memory, which even comes into play at 1,920 x 1,080, providing a 4fps boost to the best minimum we saw from a 2GB card. The difference was negligible at 2,560 x 1,440, but if you want the smoothest frame rates without stepping up to a costlier GTX 970 or R9 380X, this month's

Short supply of Intel's Skylake Core i7-6700K has muddied the waters when it comes to choosing a processor

Approved-winning Sapphire R9 380 Nitro 4GB is a great option, and the card we used in our own build.

I want to play at 2,560 x 1,440

TOP PICK: Nvidia GeForce GTX 970 4GB

Nvidia has wrapped up this increasingly popular resolution with the GTX 970, and at both High and Ultra settings in Fallout 4 too. At High settings, it managed a healthy 43fps minimum frame rate, only dropping to 29fps when we switched on all the eye candy.

I want to play at 3,840 x 2,160

TOP PICK: Nvidia GTX 980 Ti 6GB

Our particular benchmark showed Fallout 4 to be a particularly tough customer at 4K,

and even the mighty GTX 980 Ti wasn't able to tame it at Ultra detail. Overclocking the card will likely tip the 23fps minimum frame rate into playable territory, but for now, we'll assume you'll need to dial down the settings to High.

Even then, only a small selection of cards passed our 25fps playable minimum requirement, with the GTX 980, R9 390X and R9 Fury sitting only a couple of frames per second over this border. That leaves us with the GTX 980 Ti and R9 Fury X, and the former would be our choice here – it costs around £40 more, but it's faster, more overclockable, less power-hungry and doesn't require space for a liquid cooler radiator either.

Devil's Canyon vs Skylake

Short supply of Intel's Skylake Core i7-6700K has muddied the waters when it comes to choosing a processor. As a result, it isn't only far more expensive than the previous-generation Core i7-4790K, but it's also now similarly priced to Intel's 6-core Core i7-5820K.

Thankfully, if you don't need Hyper-Threading (and for most people's needs, a simple quad-core CPU is fine), the situation is more clear-cut; the older Core i5-4690K is barely £10 cheaper than the Skylake Core i5-6600K, and 16GB of DDR4 memory now costs about the same as the equivalent speed DDR3 memory. Opting for Skylake at this price makes sense – not only do you get a more efficient and better-performing CPU, but you have a much better upgrade path as well.

Shopping list

CASE

In Win 805 / **£130 inc VAT**

SUPPLIER www.scan.co.uk

You don't strictly need a swanky case, of course, but In Win's 805 offers a superb way to show off your hardware in style, as well as providing room for expansion with more hardware. If you



want to save a bit of money, though, NZXT's Phantom 530 is a great case for £98 inc VAT, while NZXT's S340 is also surprisingly good for just £60 inc VAT.

CPU

Intel Core i5-6600K

/ **£192 inc VAT**

SUPPLIER www.scan.co.uk

If you have no intention of overclocking your CPU, then consider one of Intel's non-K-series Core i5's, but we're definitely looking to do some tweaking, so we've opted for a multiplier-unlocked Core

i5-6600K. The Core i7-6700K does offer Hyper-Threading and a slightly higher stock clock speed, but it demands a huge premium for the privilege, and Hyper-Threading has a negligible impact on gaming anyway.



MEMORY

8GB Corsair Vengeance LPX 2666MHz / **£47 inc VAT**

SUPPLIER www.overclockers.co.uk

If you're not looking to do any heavy



rendering work, or run many virtual machines, then 8GB of memory is still fine for an everyday PC, and still more than enough for current games. Opt for a dual-channel kit consisting of two 4GB DIMMs. Speed-wise, 2666MHz is the current DDR4 sweet spot – you see diminishing returns and increasing premiums for higher frequencies. If you need more memory then Corsair's 16GB Vengeance LPX set will still leave you plenty of change from £100.

GRAPHICS CARD

Sapphire R9 380 Nitro
4GB/£175 inc VAT

SUPPLIER www.ebuyer.com

Our graphics card choice comes from our own Fallout 4 performance testing and the fact that our system build is focused on 1080p gaming. Here, the Sapphire R9 380



Nitro 4GB shines, with a minimum frame rate of 34fps even at Ultra settings, thanks to its extra 2GB of memory compared with standard models. If you're prepared to drop the detail from Ultra to High, you'll see playable frame rates at 2,560 x 1,440 too, plus it was one of the quieter R9 380 cards in our group test this month. If you want to keep heat and power consumption to a minimum, however, Nvidia's GeForce GTX 960 is a better bet for 1080p gaming.

MOTHERBOARD

ASRock Z170
Extreme4/£116 inc VAT

SUPPLIER www.ebuyer.com

Despite costing just over £100, the ASRock Z170 Extreme4 was able to push our Core



i7-6700K to its limits in testing, while offering an impressive array of features too. It sports all the usual overclocking and testing tools, has a great layout and is compatible with the latest super-fast M.2 and PCI-E NVMe SSDs as well. Asus' Maximus VIII Ranger sports more features and arguably looks better, but it costs around £30 more, making the Z170 Extreme4 the ideal choice for a budget-conscious build.



CPU COOLER

Corsair Hydro Series
H75/£60 inc VAT

SUPPLIER www.pcworld.co.uk

If you're overclocking your CPU, Corsair's H75 has ample cooling capacity to cope, and it's also fairly quiet and easy to install. If you want the very best cooling and lowest noise, regardless of price, you can consider EKWB's awesome Predator 240; however, if you're keen to save some cash, an air cooler such as SilverStone's Argon AR01 will leave you £30-40.

SSD

Crucial 250GB
BX100/£63 inc VAT

SUPPLIER www.dabs.com

For most of us, 250GB is enough space for a couple of modern games and an operating system with room for other programs too.



Here, the Crucial 250GB BX100 SSD is your best option for affordable, fast storage, combined with a hard disk for storing files and occasionally used programs. Of course, if you're a heavy gamer and simply need as much SSD storage space as possible – after all, titles such as GTA V take up more than 50GB – then don't be afraid to opt for the 500GB version, which will set you back another £60 or so.

HARD DISK

Seagate Barracuda
2TB/£53 inc VAT

SUPPLIER www.scan.co.uk

While we absolutely recommend using an SSD for your operating system, games and regularly used programs, a hard drive still offers much better value for storage of large amounts of media and data, so we've opted for a 2TB Seagate Barracuda hard drive.



PSU

EVGA SuperNova GS
550W/£65 inc VAT

SUPPLIER www.scan.co.uk

Finally, you'll need to power the PC and, as the Intel Core i5-6600K is fairly power-frugal, even when overclocked and combined with an R9 380, the system won't be drawing more than 400W under full load from the mains, which is unlikely to happen in games anyway. As such, our currently Elite-listed EVGA SuperNova GS 550W will do the job fine.

TOTAL: £901 inc VAT

Building the PC

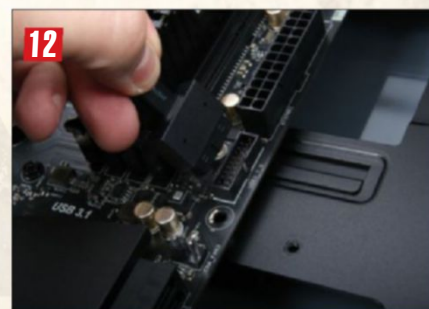
Your first job is to install the CPU. Remove the socket's plastic cap, slide out the lever, open the CPU latch and move the CPU over the socket from the side, lining up the notches on its edges with those on the socket; then push down the lever and lock the CPU into place. **01** Moving the CPU into place from the edges reduces the height it could fall into the socket, potentially damaging the pins beneath. You can then install the memory in alternating slots in order to enable dual-channel mode **02**.

Next up is the CPU cooler mount. Our Corsair H75 requires the use of a backplate, which needs to be installed first **03**, followed by the mounting pins on the top side of the motherboard that screw into the backplate **04**. The pump section sits on top of these pins and is secured by four thumbscrews, but you don't want to fit the pump section until you've mounted the motherboard in the case.

Before you install the motherboard, check there are sufficient standoffs installed, so you don't short out your

motherboard's solder points on the metal case. **05** We needed to screw a few more standoffs into place to cater for our ATX motherboard's mounting holes, and these standoffs are included with the case. Next, make way for the H75 cooler's radiator by removing the rear 120mm fan **06**.

The In Win 805's front fan mounts are removable, enabling you to install fans between the mount and the front of the case. Two large thumbscrews hold the mount in place – remove it so you can fit the 120mm from the rear in the front **07**.





Use the same screws that held the fan in the rear of the case – you won't need them to mount the H75 cooler **08**.

The rear I/O shield fits a little strangely in the 805 – it doesn't install at the outer edge of the case, but between two lips that point inwards. It's much easier to install than other cases as a result though **09**. Once the I/O shield is fitted, it's time to install the motherboard. Use all the available mounting holes to secure it and make sure it lines up with the I/O panel **10**.

There are a few connectors that you need to attach to the motherboard. For starters, there are the front panel connectors, such as the power button plus any USB ports. The front panel header pins will be labelled in your motherboard's manual – usually for the power and reset buttons, plus the power and hard disk activity lights **11**. There are separate headers too, such as the USB 3 header and audio header, which you'll also need to connect to the appropriate cables in your case **12**.

Now, place one of the H75's fans into the rear fan mount as an exhaust (with the fan's plastic barriers facing the back of the case), and thread the four mounting screws

through the holes **13**. Secure the second fan to the front of the radiator, then attach the radiator to the first fan in the case. You can now install the pump section to the motherboard using the four thumbscrews. Thermal paste is pre-applied, and the thumbscrews have limited threads, so screw them all the way until headers **14**. It's best to use a 4-pin Molex to 3-pin fan adaptor to connect the pump, rather than a 3-pin fan header, so you can run it at the maximum 12V. Alternatively, you can



switch off fan control for that particular fan header on your motherboard.

The case's hard drive mounts are tool-free, **15** while the SSD mounts require screws **16**. You can use any of the appropriate mounts – there are several for each size of drive. Meanwhile, the graphics card simply slots into place in the top 16x PCI-E slot **17**.

Now it's time to install the power supply in the mount at the bottom of the case **18**. As it's a modular PSU, you can remove any unwanted connectors. Hook up the 24-pin ATX connector and 8-pin EPS 12V connectors to the motherboard's power sockets **19**, then hook up two 6-pin PCI-E plugs to the sockets on the top of your graphics card. Finally, connect the SATA cables between your two drives and your motherboard **20**.

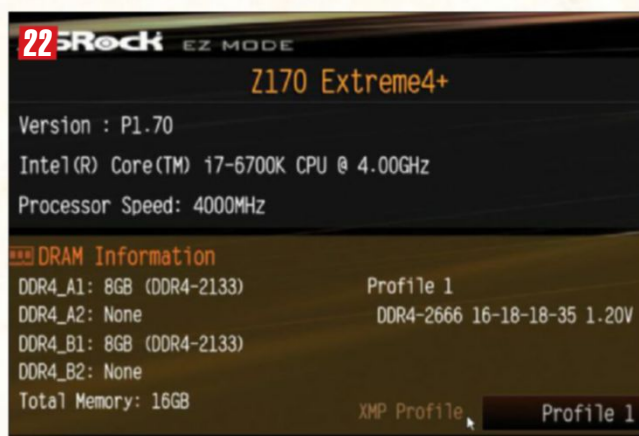
Cable routing is a necessary evil to keep your PC clutter-free and improve airflow. The 805 case includes several large cable anchors and plenty of cable ties, which you can use to route the cables neatly behind the motherboard tray **21**. You can then power on the system and install Windows and your programs.

OVERCLOCKING THE CPU AND GRAPHICS CARD

We've applied some fairly modest overlocks to our system, including boosting the CPU frequency to 4.3GHz using a vcore of 1.25V. Head into the EFI by tapping the Del key when your system starts. Firstly, in the front page in EZ Mode, go to DRAM Information and select Profile 1 under the XMP Profile section on the left **22**—this setting applies the correct RAM frequency and timings. Next, press F6 to enter Advanced mode and head to the OC Tweaker tab and CPU Configuration. In this section, set the CPU ratio to 43 **23**. Finally, head to Voltage Configuration and set

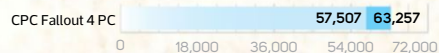
the CPU vcore mode to Fixed, and the voltage itself to 1.25V **24**.

Then, to overclock the graphics card, download and install MSI Afterburner (www.majorgeeks.com) then set the power limit to +20, the core to 1090MHz and the memory to 1550MHz **25**. In Fallout 4, these settings resulted in a 9 per cent boost to the minimum frame rate at Ultra settings at 1,920 x 1,080, and a 7 per cent boost at 2,560 x 1,440. Sadly we couldn't quite get the game to a playable level at 2,560 x 1,440 with Ultra settings, but at High settings, a minimum frame rate of 32fps at this resolution is perfectly smooth. **CPC**

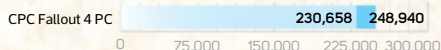


CPC REALBENCH 2015

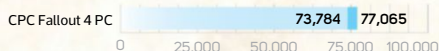
GIMP IMAGE EDITING



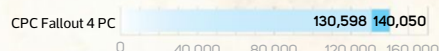
HANDBRAKE H.264 VIDEO ENCODING



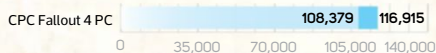
LUXMARK OPENCL



HEAVY MULTITASKING



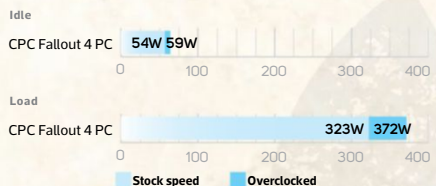
SYSTEM SCORE



INTEL REFERENCE

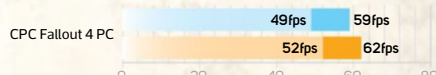


POWER CONSUMPTION

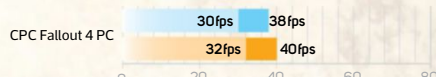


FALLOUT 4

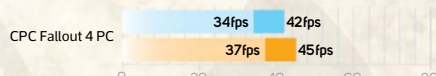
1,920 x 1,080, High settings



2,560 x 1,440, High settings

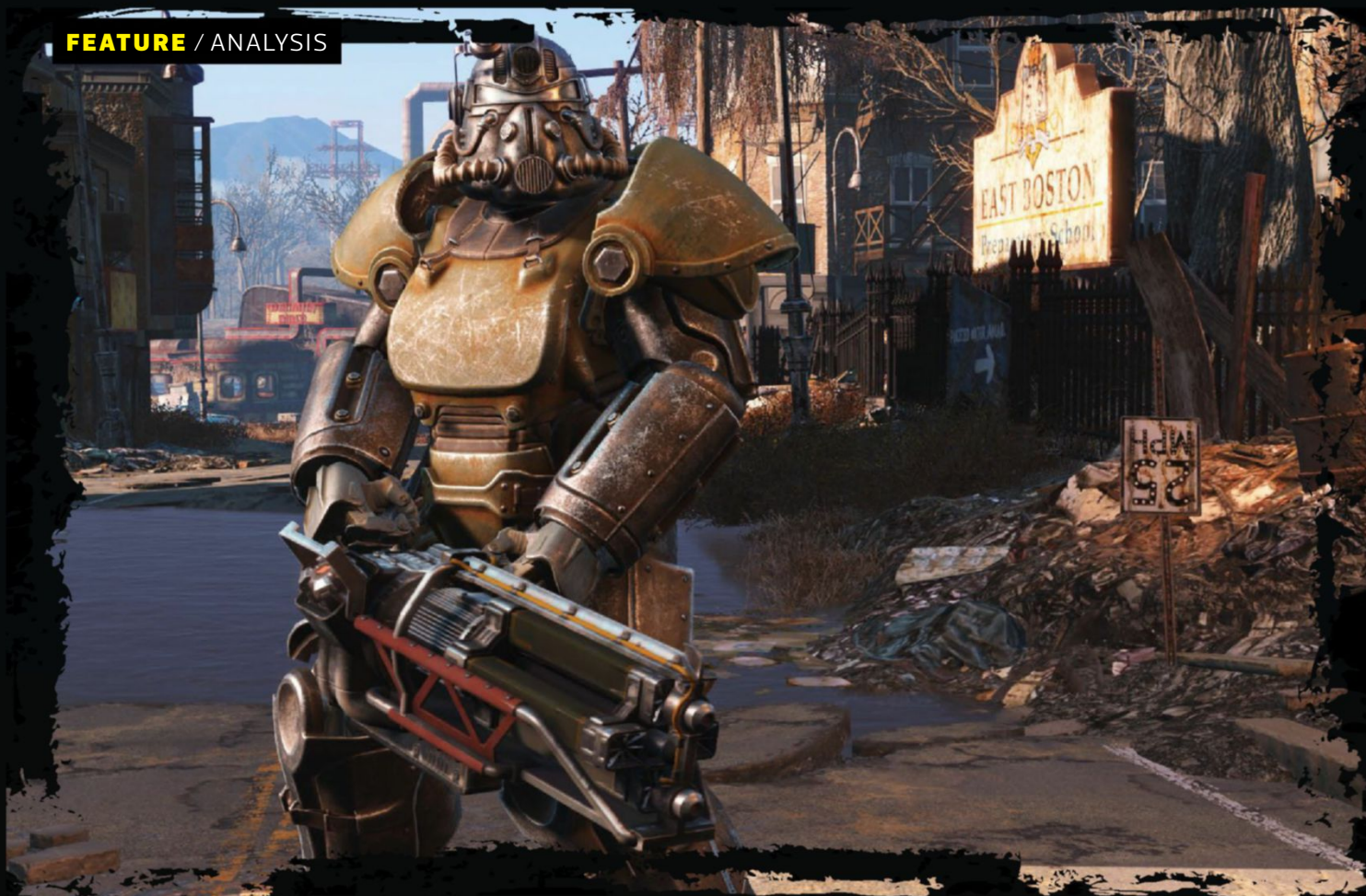


1,920 x 1,080, Ultra settings



2,560 x 1,440, Ultra settings





What you need to run

Fallout 4

Bethesda's latest post-apocalyptic RPG is admittedly a cross-platform game, and not a graphical masterpiece in the way as *The Witcher 3* but nonetheless, as you'll see, good PC hardware is needed to show off the game at its best. The game is the second major release to use Bethesda's own Creation Engine, the first being *The Elder Scrolls V: Skyrim*. As you'd expect, however, Bethesda has made some tweaks and introduced new rendering features to Creation for *Fallout 4*. There's a clear visual upgrade

as a result, and in parts, the game will make even top-tier cards cry in agony.

A major new feature is the physically based deferred renderer, which affects lighting and how it reflects off distinct surfaces, particularly metals compared with non-metals. Dynamic volumetric lighting is the other big addition – a realistic, real-time way to render light shafts that complements the game's built-in dynamic time of day and weather systems.

Fallout 4 might not be the best-looking game of the year, but it's a very

detailed, vast open-world game that uses advanced rendering techniques. As such, we set about creating a benchmark to compare cards and find out what hardware you'll need to play the game as the developer intended.

THE BENCHMARK

Fallout 4 lacks a built-in benchmark, so we set about creating a manual play-through test that was both repeatable and challenging. We eventually discovered a suitable woodland area in the outskirts of the Corvega Automation

Plant, through which our character runs forwards for 30 seconds. The benchmark is run with the first-person viewpoint and is reliably repeatable; there's no combat or interruption from NPCs, although our canine companion, the ever faithful Dogmeat, runs ahead and is in shot for the most part.

It's an outdoor scene with plenty of foliage, objects and shadows in the distance, keeping the potential draw distance high. Multiple trees, stripped of their leaves by radiation, stand against the sky just begging for some anti-aliasing, while the low morning sun casts long complex shadows across the scene, taking full advantage of the game's volumetric lighting.

Our benchmark is more GPU-intensive than most of the game. You can run around the game world with frame rates averaging over 60fps, but still drop close to a 30fps minimum in our benchmark. However, it's these drops that you'll notice during gameplay, and it's no good having a card that can only cope in some sections. All cards are tested at reference frequencies, apart from the MSI GTX 960 Gaming 2G and Asus GTX 950 Strix, both of which feature small overlocks. The results are still representative, however, as these overlocks will only result in a few more frames per second here and there.



Detail presets

Like Skyrim, details are set prior to launching the game. The launcher gives you a drop-down menu for resolution, anti-aliasing and anisotropic filtering options. You then have four quality presets from which to choose – Low, Medium, High and Ultra – but it's possible to customise these settings further in the Advanced menu. You can then play with 19 options, 13 to tweak the detail and effects, and six to adjust the view distance.

The experience on Low is, frankly, rubbish. Shadows in particular are laughably low-resolution and draw distance is set to an absolute minimum, so objects pop in and out of view as you

Our benchmark uses an outdoor scene with plenty of foliage, objects and shadows in the distance

move in a distracting fashion. The jump to Medium gives you the most obvious step up in quality.

Shadows are drastically improved, and volumetric lighting is added, which is especially noticeably in sunlit scenes. Extra detail such as blood splatters are also added to scenes and the amount of foliage noticeably increases, as does the draw distance.

Lighting and draw distance are the two main factors affected again as you move to High and Ultra (with only a subtle difference between the two); however, the effects are subtler, usually affecting the background more noticeably than the foreground, although the background is, of course,



You can see the amount of foliage, and the detail on trees and shadows, increasing as you take up the detail



important for immersion in an open world game. Shadows also become softer at these settings, and more diffuse and volumetric lighting is increased. Textures in Fallout 4 are sadly not actually ever that high resolution on many objects, but the High and Ultra settings ensure objects are rendered even when you're very far away from them so that they slowly increase in detail as you move closer rather than just popping into view awkwardly.

Performance

To run the game consistently smoothly at Ultra detail, your best bet is either an R9 380 or GTX 960 for 1080p gaming, both of which never dropped below 30fps at these settings. At 2,560 x 1,440, though, even the GTX 970 just misses the 30fps minimum target at Ultra detail, though a bit of overclocking

Without anti-aliasing, the game's jagged edges are really quite distracting

should see to that. Meanwhile, AMD's equivalent, the R9 390, passes with a strong result of 34fps. At 4K, however, no single card can handle our benchmark at Ultra settings, with the best result being an underwhelming 23fps minimum.

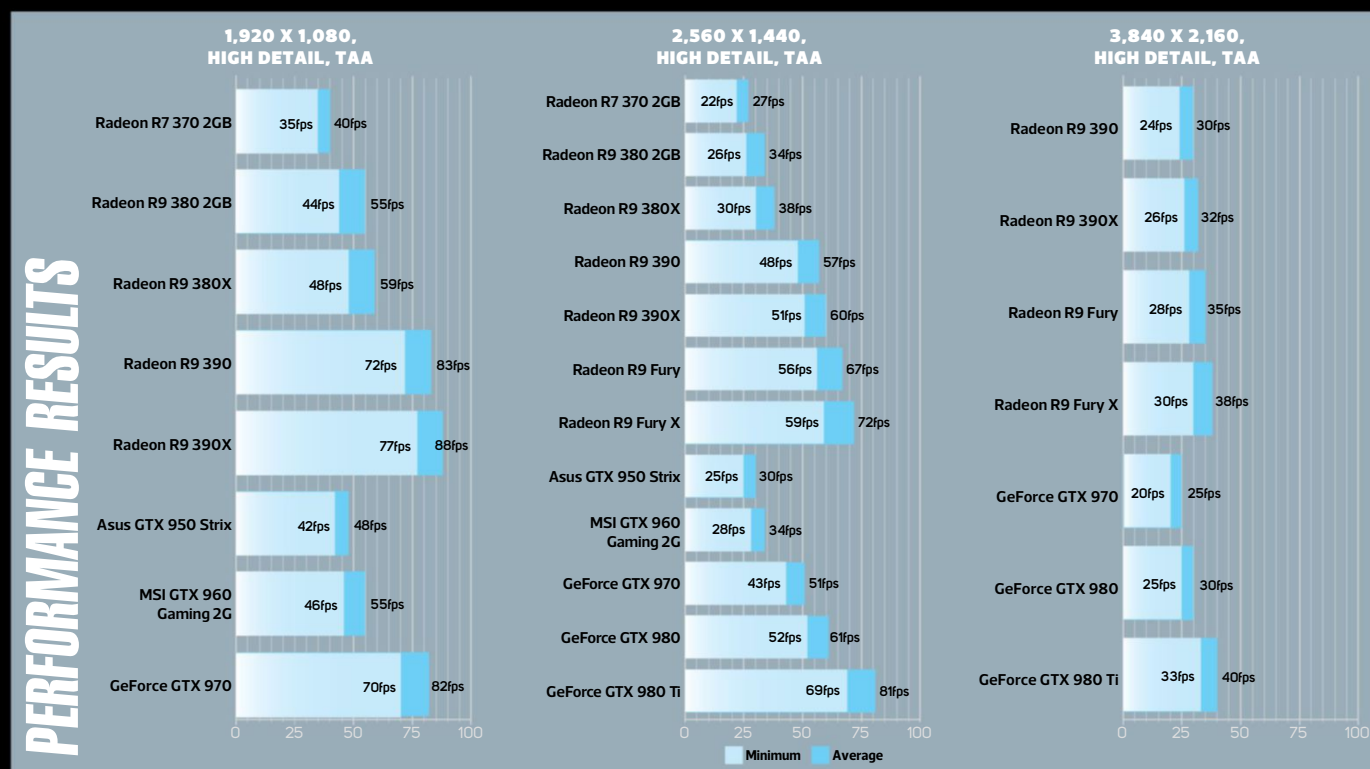
The High detail preset provides the best balance of performance and image quality, and dropping to this setting sees the barrier to entry lowered at each resolution. The performance gain from doing so equates to an average of over 40 per cent for both AMD and Nvidia GPUs. At these settings, all tested cards can play the game smoothly at 1080p, while a GTX 970 and above will sustain 60fps. At 2,560 x 1,440, a Radeon R9 380X will serve you well enough. At 4K, however, only the two flagship cards are capable of sustaining at least 30fps at High settings.

Anti-aliasing

There are only two anti-aliasing options in Fallout 4 – FXAA (fast approximate anti-aliasing) and TAA (temporal anti-aliasing). The good news is that neither method has much impact on performance, as they both rely on analysing frames after rendering rather than sampling additional pixels during the actual render process.

FXAA seeks out edges in each frame and performs a quick and dirty smoothing effect, while TAA analyses differences between frames and tends to affect more of the image. Our Fury X saw no change in its minimum frame rate using either method, while the GTX 980 Ti only lost 1fps with FXAA enabled and 1fps more with TAA.

TAA has the superior image quality, especially when it comes to textures that are prone to aliasing, such as





foliage, trees and mesh fences, although it does result in a slight loss of detail and sharpness, sometimes called the Vaseline effect. FXAA is less prone to this effect, but is weaker in other areas. Ultimately, it comes down to personal preference, but you should definitely choose one. Without anti-aliasing, the game's jagged edges are really quite distracting. Our screenshots are taken at 4K, but the effect is even more apparent at lower resolutions – even the game's Low preset includes FXAA.

Godrays

Dynamic volumetric lighting is one of the bigger improvements to the Creation Engine, and the setting that most clearly illustrates it is Godrays, referring to the real-time tracing and rendering of beams of light coming from the sun and other bright light sources.

Depending on your in-game location, the time of day and the weather, the visual impact of Godrays ranges from stunning to practically non-existent.

You can disable Godrays or set them to Low, Medium, High or Ultra, although the latter has a large performance impact – even the general Ultra preset only sets it to High.

The difference between disabled and Low is clear in certain outdoor scenes, with the beams of light adding a distinct, atmospheric haze to the irradiated Commonwealth air and piercing the space between objects.

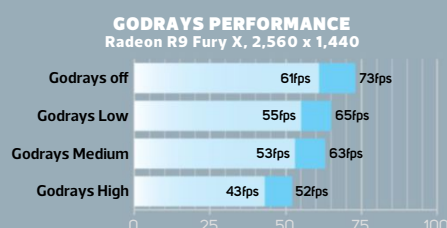
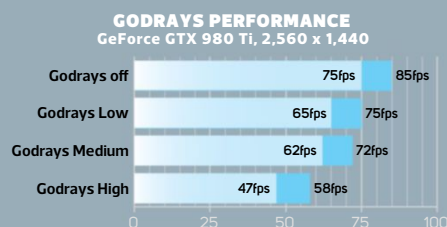
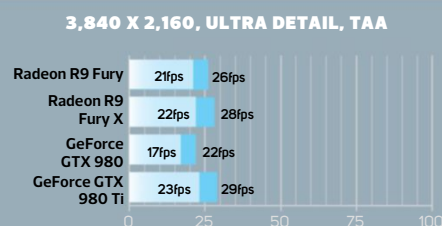
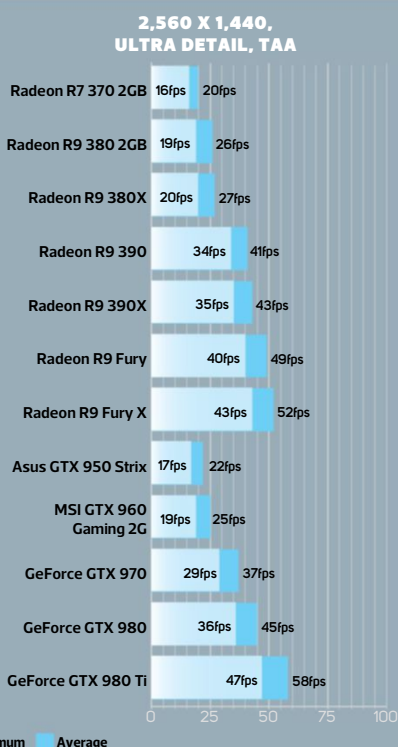
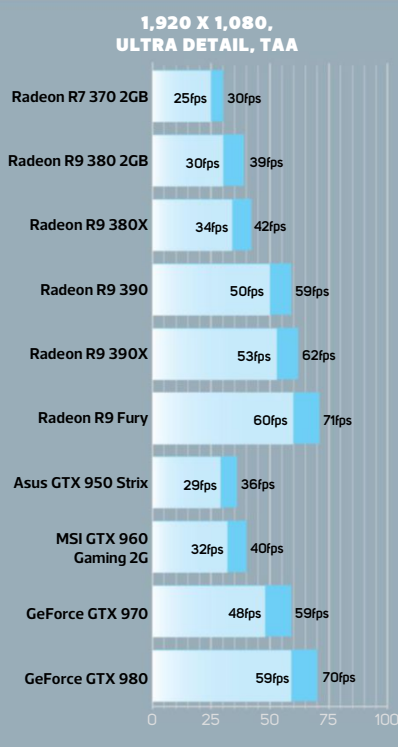
Above Low, the changes are subtler, but involve smoothing out the edges of the beams and the objects through which they pass. The effect is

Disabling Godrays improved performance by over 10 per cent, but the lighting definitely feels staler without it

hard to capture standing still, but it's certainly pleasant. To assess its impact on performance, we repeated our benchmark on the general Ultra preset, but dropped Godrays to Medium, Low and disabled.

Godrays are probably the most demanding of any of the 19 advanced settings exposed to users. When going from High to Medium, the R9 Fury X gained 23 per cent in performance, while the GTX 980 Ti gained 31 per cent. Moving to Low, however, only saw improvements of less than 5 per cent, while disabling Godrays altogether improved performance by over 10 per cent but the lighting definitely feels staler without it. If you find your hardware slowing down drastically in certain sections of Fallout 4, dropping Godrays from High to Medium would be a good place to start your tweaking. **GPU**

The visual impact of Godrays ranges from stunning to practically non-existent





GARETH HALFACREE'S

Hobby tech

The latest tips, tricks and news in the world of computer hobbyism, from Raspberry Pi, Arduino and Android to retro computing

REVIEW

Raspberry Pi Zero

Regular readers will know there's never a shortage of single-board computers for me to review, but this month's arrival is the first such computer I've seen that costs less than £5, putting it firmly into the pocket-change bracket that was previously the exclusive domain of microcontrollers. Yes, it's the Raspberry Pi Zero – and if you're lucky enough to have picked up some of the early stock, you'll know it's very special indeed. First, though, we need to address the elephant in the room: this isn't a £4 computer.

Even assuming you don't have to pay postage – £2.50 from <https://shop.pimoroni.com> for a Pi Zero on its own – there are a few other bits and pieces you'll need to get going: a micro-SD card, from £2; a power supply and micro-USB cable, from £3; a mini-HDMI adaptor or cable, from £1; and a USB OTG adaptor, from 50p. Adding up those costs, and assuming you're happy buying from AliExpress or similar

Pretty tiny, eh? Who'd guess this board is a full computer capable of running Linux or even the classic RISC OS?

Chinese outlets and waiting a couple of weeks, the £4 computer becomes a £10.50 computer – only dipping below the £10 level if you're happy to hang the device from an existing USB power adaptor.

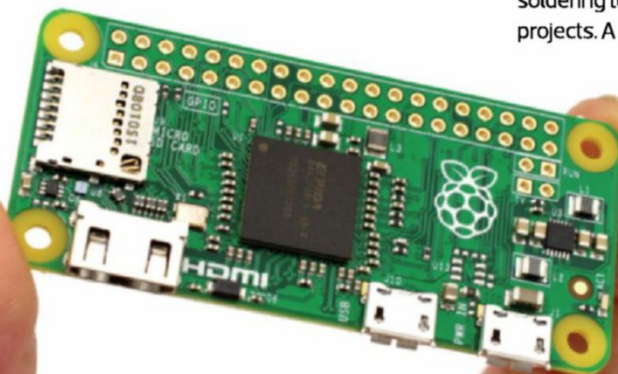
While 'the £10.50 computer' doesn't have the same ring to it as 'the £4 computer', it's nevertheless quite an achievement. Anyone who was impressed by the original Raspberry Pi Model B launching for a sub-£30 price sans accessories will be blown away by the Zero: it's the same BCM2835 system-on-chip processor, boosted from 700MHz to 1GHz and with 512MB of RAM stuck on top, but for a fraction of the price.

So, how has the Raspberry Pi Foundation done it? A quick glance at the extremely tiny circuitboard – small enough to fit inside a Smint tin with room for cables – reveals several cut corners.

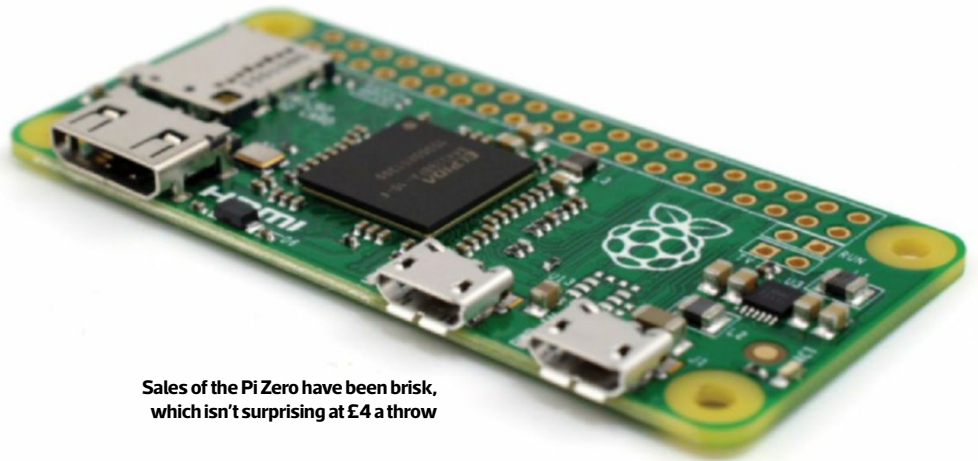
There's no networking, for a start, making the Zero a close relative to the Model A+ but with twice the RAM. The analogue audio port has also gone, as has its built-in composite video output – an unpopulated header lets you add composite video yourself, but there's little point without audio to go with it.

The general-purpose input/output (GPIO) header is present and correct, but unpopulated, so you'll need to do a bit of soldering to get the Pi Zero ready for your projects. A bigger issue is the loss of the CSI

camera and DSI display interfaces, meaning displays have no choice except to hang off the HDMI port (or composite header), while all peripherals will need to be shoved through the finicky Pi USB implementation, and via a single port as well. So far, this review is sounding a little negative –



I was unable to make the Raspberry Pi Zero draw any more than around 160mA when under load

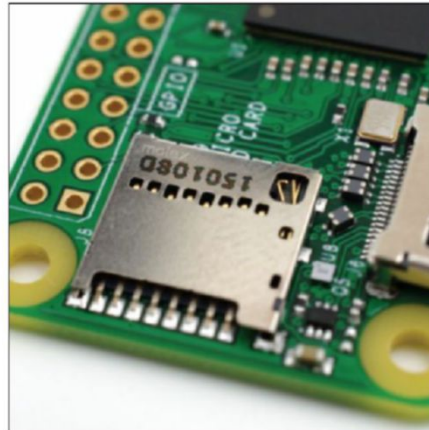


Sales of the Pi Zero have been brisk, which isn't surprising at £4 a throw

which is why you may be surprised to hear that I absolutely love the Pi Zero. For most projects where a Model A+ would have been appropriate, the Pi Zero can do it cheaper, in a smaller footprint and at a considerably lower power draw. I was unable to make my Pi Zero draw more than around 160mA under load, making it the most energy-efficient Pi by far and entirely suited to running from a battery or a PC's USB port.

The lack of networking is a bit of an issue, but one that's easily resolved with a cheap USB Wi-Fi dongle that adds no more than £5 to the cost – and I'm currently waiting on delivery of a £1.54 unit from China to see if it will work. Another option is to connect an ESP8266 module to the GPIO header, giving you serial-connected Wi-Fi that's perfect for low-bandwidth applications such as environmental monitoring.

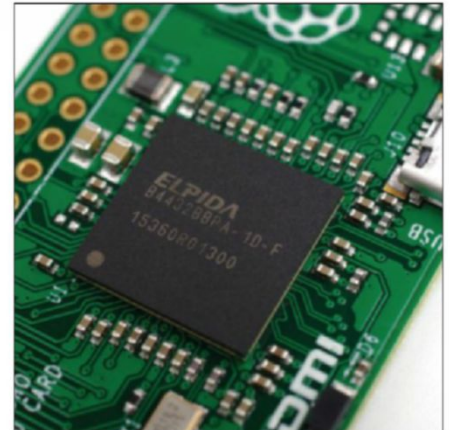
There's good news for anyone who has already invested in the Pi ecosystem too: any add-on device that's compatible with a Model A+ will work just fine on the Pi Zero. I've tested mine with everything from a Pimoroni Unicorn



Micro-SD cards used in any existing Pi model work just fine on the Zero, as long as the OS is updated

Hat to a sub-£10 2.4in touch-screen display and encountered no compatibility issues or power problems – a testament to the Foundation's desire to retain compatibility among its various releases.

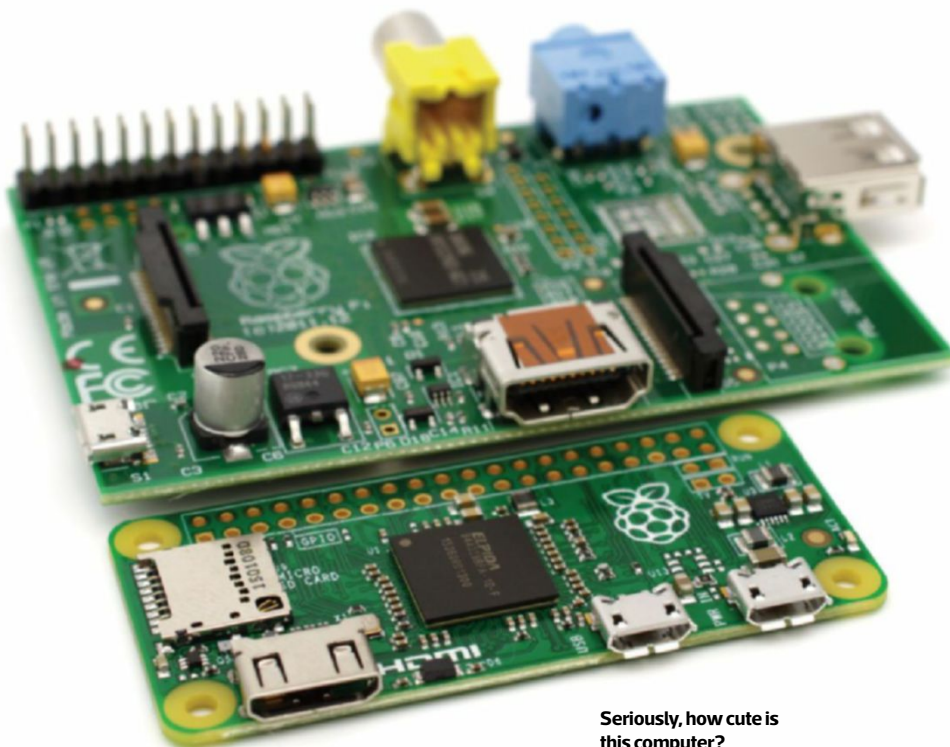
The key to the Pi Zero's success will be its availability. Its first production run sold out



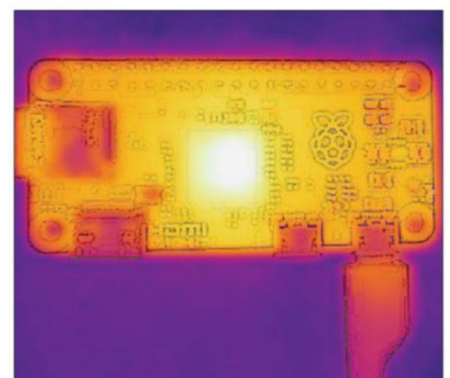
Aside from a speed bump to 1GHz, the BCM2835 is unchanged from the original Pi boards

within a day, thanks in no small part to it being glued to the cover of The MagPi magazine, and at the time of writing, there were no more due to be available until mid-December. If the factories are run full tilt, the Pi Zero will be a smash hit – but the question needs to be raised of just how much the '£4 computer' costs to make. If I learned that the cost of the device was heavily subsidised in order to hit the headline-making price, I wouldn't be surprised, but I'd wonder how long such an arrangement could be sustainable.

The Pi Zero may, or may not, be available from stockists <http://swag.raspberrypi.org>, <https://shop.pimoroni.com>, and <http://thepihut.com> for £4 inc VAT when this issue hits the shelves.



Seriously, how cute is this computer?



Even at full load, the SoC's temperature didn't go much over 38°C, and all other components run cool



TUTORIAL

Raspberry Pi True Random Number Generator (TRNG)

There's a criminally underused feature of the Raspberry Pi's BCM283x processor that few people know about: a built-in, supposedly cryptographically secure, true random number generator (TRNG). It's the sort of feature that's a little wasted on a device you're using to flash your Christmas lights, but would be of great use to a server, which is why I decided to wire one into my HP MicroServer; the processor in this doesn't include a Linux-compatible TRNG.

1 Prepare the Pi Zero

The Pi Zero is a great choice for this project, with only one problem: it arrives with the GPIO headers unpopulated. If you're using any other Pi model, you can skip this step, but the Zero needs you to solder headers before you can use the GPIO features. The good news is that this process is easy and also provides a great introduction to soldering.

You'll need either two rows of 20-pin headers – snap the typical 36-pin lengths to size by hand at the indentation points between pins 20 and 21 – or one 2x20 set – the former is typically cheaper. Insert the pins into the GPIO header from the top and secure them by inserting them into a breadboard – or, at a pinch, with Blu-tac. Solder each pin carefully from the underside of the board, making sure not to short out any parts.

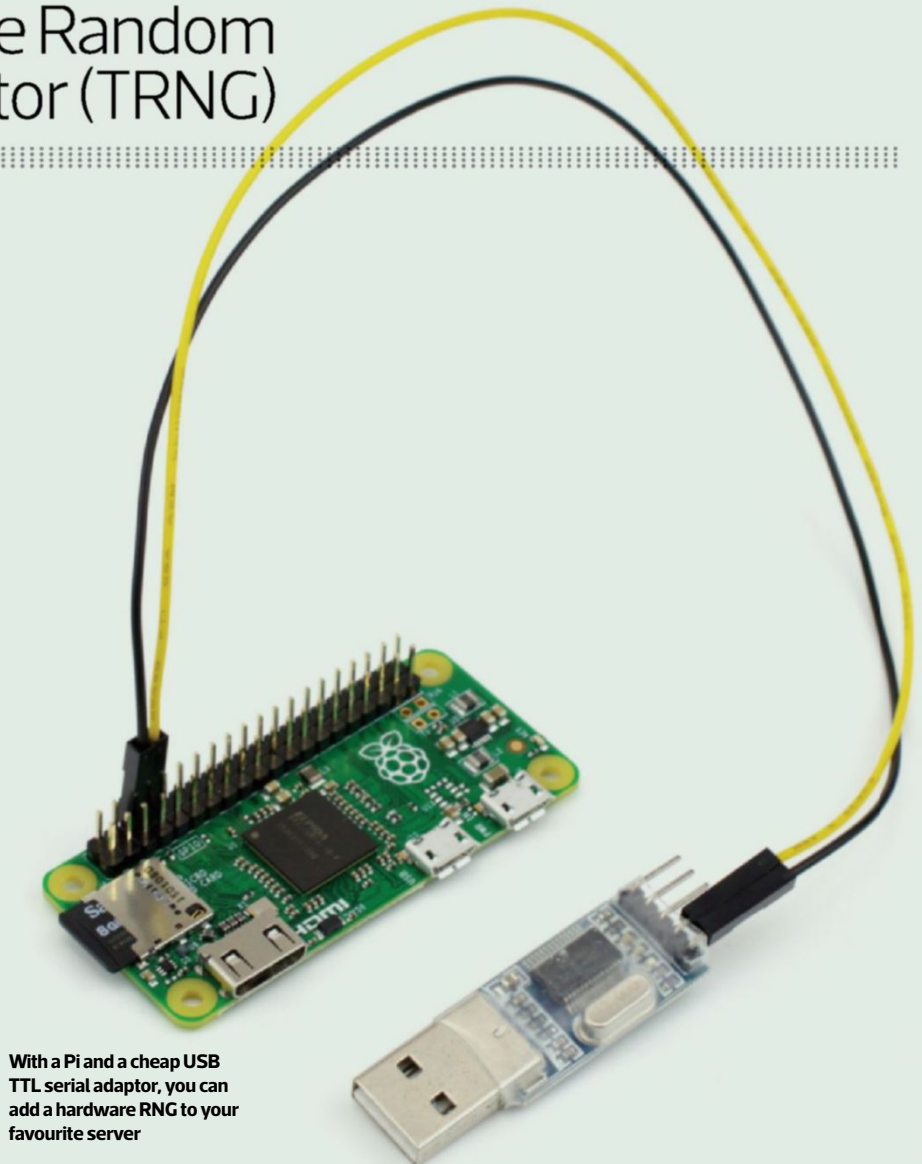
WHAT YOU'LL NEED

Raspberry Pi (any model) /
£4–£30 inc VAT,
<http://cpc.farnell.com>

3.3V USB-TTL serial dongle /
£1.89 inc VAT,
www.aliexpress.com

Female-to-female jumper wires /
£5 inc VAT for 30,
<http://oomlout.co.uk>

Male headers (optional) /
£1.50 inc VAT for four,
<http://oomlout.co.uk>



With a Pi and a cheap USB TTL serial adaptor, you can add a hardware RNG to your favourite server

2 Software configuration

Boot your Pi, and get yourself to a terminal. Log in, and edit the modules file:

```
sudo nano /etc/modules
```

At the end of the file, insert the following line to activate the Pi's hardware random number generator module:

```
bcm2708-rng
```

Add a blank line at the end, save with Ctrl-O and quit with Ctrl-X. Next, edit the serial port configuration by typing the following:

```
sudo raspi-config
```

At the menu, select '9. Advanced Options,' then 'A8. Serial,' and confirm you don't want the serial console active by selecting 'No'. Choose 'Finish' then allow the Pi to reboot.

3 Linking serial and RNG

The Pi's RNG is now active, but only for local use. We want to use it as an add-on RNG for

an external machine, so we need a way to get out the data, for which a serial connection is the logical choice. Thankfully, the Pi has a built-in serial port. Log back in and type the following:

```
sudo nano /etc/rc.local
```

Just below the commented-out section – the lines that start with hashes – type the following two lines:

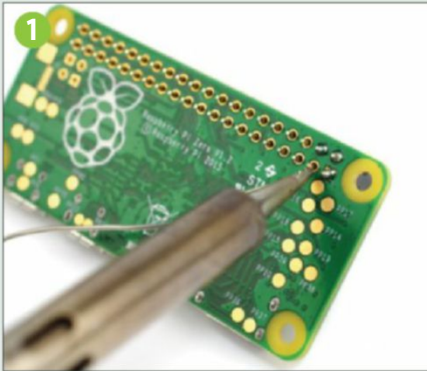
```
stty -F /dev/ttyAMA0 -echo raw
115200
```

Save with Ctrl-O and quit with Ctrl-X. This part configures the serial port and sets up a process to continuously copy the output of the RNG. You can now shut down the Pi with:

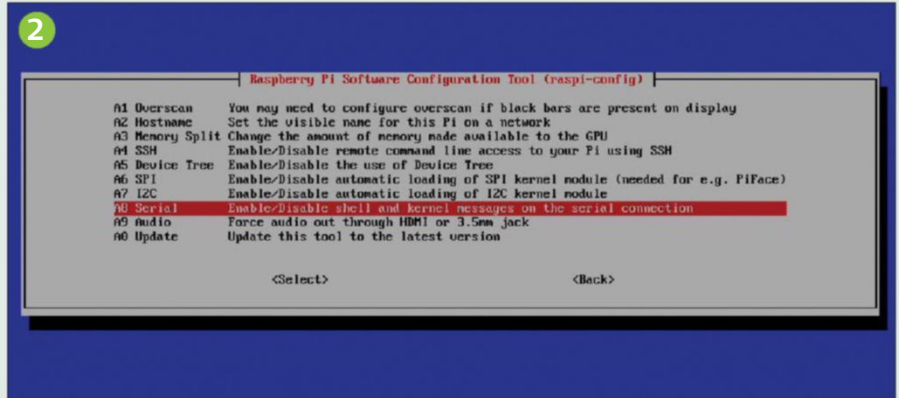
```
sudo shutdown -h now
```

4 TTL to USB

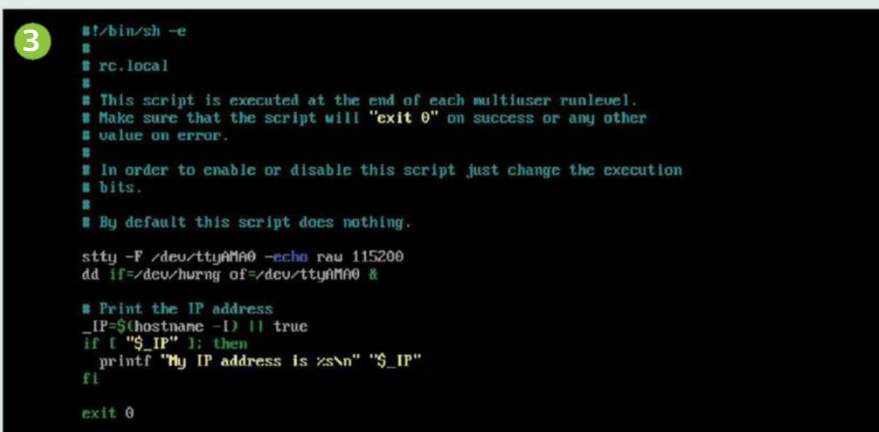
The Pi is now configured to spit out entropy over its serial port, but there's one problem:



If you're using a Pi Zero, you'll need to solder on GPIO headers before you can use its serial port



Using raspi-config, disable the Pi's serial console to free up the TTL serial port for your own use



By putting these lines in rc.local, you make the Pi run them every time it boots up – even if nobody logs in

few servers have user-accessible TTL-level serial ports. The solution is a USB TTL adaptor, which connects to the server's USB port and gives it a TTL serial connection compatible with the Pi.

You only need to connect two wires to the Pi: wire the TTL adaptor's RX (receive) pin to Pin 8 (transmit) on the Pi's GPIO header, and wire the TTL adaptor's GND (ground) pin to Pin 6 (ground) on the Pi. If you're using a Pi Zero and a TTL adaptor with a 5V or 3.3V output, you could try powering the Pi via the GPIO header, although other models of Pi will likely draw too much power for such a setup to work. If you'd rather not try, simply use a micro-USB cable to power the Pi instead.

5 Server configuration

To feed the Pi's entropy to a Linux server, such as mine, connect the USB TTL serial adaptor plus the Pi's power cable – if used – to USB ports. Then log in to the server and type:

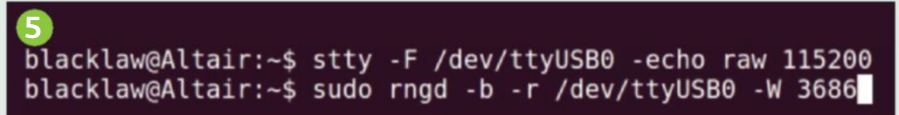
```
ls /dev/tty*
```

Depending on the chip used, your TTL adaptor will show up as ttyUSB0 or ttyACM0. Figure out which, then install the rng-tools package:

```
sudo apt-get update && sudo apt-get install rng-tools
```



You only need two wires between the Pi and the USB adaptor, or three if you're using the adaptor for power



You can run the commands on the server without rebooting, or add them to rc.local to activate on every boot

Edit rc.local:
 sudo nano /etc/rc.local
 Then add the following lines above 'exit':
 stty -F /dev/ttyUSB0 -echo raw 115200
 rngd -b -r /dev/ttyUSB0 -W 3686 &
 Save the file with Ctrl-O, exit with Ctrl-X and then reboot the server.

When the server comes back up, it will do so with an entropy pool that never drops below around 90 per cent full. This will effectively give you higher security for everything from key generation to SSH sessions, assuming of course that you trust Broadcom's claim that the hardware RNG is truly random.

NEWS IN BRIEF

Nvidia launches Jetson TX1

The Nvidia Jetson TK1 (see Issue 133, p104) has a successor: the Jetson TX1, an ultra-compact variant that's built with machine learning projects in mind. Designed in a computer-on-module format, which is only 'credit card size' if you ignore the expansion board and large active heatsink included in the bundle, the board includes four 64-bit ARM Cortex-A57 chips and a 256-core Maxwell GPU, along with 4GB of DDR4 memory. Sadly, the price has increased along with the specification – US pricing has been set at \$599, with UK pricing yet to be confirmed.



REVIEW

CodeBug

The CodeBug suffered from terrible timing when it launched on Kickstarter earlier this year. While the project had been in stealth mode for a significant period, it went live just after the BBC announced its own micro:bit microcontroller project – leading people to assume the CodeBug was ripping off the micro:bit, rather than the micro:bit having been inspired by the CodeBug. That didn't prevent it from being successfully funded, though, and with the micro:bit now delayed into early 2016, the CodeBug is enjoying reasonable success in the education sector.

It's easy to dismiss the CodeBug as a toy thanks to its cutesy design – a design ditched by the BBC in favour of a more utilitarian micro:bit – but it's practical as well as cutesy. The two buttons sit clear of the main body for easy access without fouling the micro-USB connector, and the oversized power and GPIO connections are well suited to crocodile clips or conductive thread projects. Wearable use has definitely been at the forefront: as well as the thread-ready eyelets, there's a battery holder on the back for a CR2032 cell.

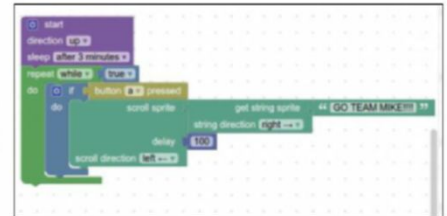
At its heart, the CodeBug runs a Microchip PIC18F microcontroller, which might not be as familiar as an Atmel ATmega or an ARM-based microprocessor, but the real secret sauce behind the CodeBug's popularity lies not in the hardware itself but in the software, which runs completely in the user's browser.



The CodeBug is cute, but there's a surprisingly flexible device hidden under its kid-friendly exterior

The main programming interface is based heavily on the Scratch-style visual programming paradigm, with simple blocks representing everything from loops and logic comparators to controls for the on-board 5x5 LED matrix. The blocks are dragged onto a central sheet and then organised according to the way you want your program to flow.

Some people are sceptical about block-based visual programming systems, but they offer a great way for beginners to get started and help teach the central concepts – after all, is it really that different from the dark old days



The web-based IDE, Blockly, is user-friendly and offers drag-and-drop programming

when learning to program involved drawing interminable flow-charts on paper?

A code viewer also lets you see what's happening under the hood, although there's no support for editing within the IDE. However, a really neat feature of CodeBug's online IDE is located at the top of the page: a simulator that allows you to see exactly what your program will do, even if you don't have a physical CodeBug to hand. We'd love to see more of these types of features from microcontroller developers.

Compiling and flashing your code has been made as simple as possible, too. Hit the Download button, and you'll be given a compiled version of your program. Connect the CodeBug's micro-USB cable while holding the left-hand button and it appears as a USB Mass Storage Device; drag and drop the file to this device, eject it and you're done. If you've ever wrestled with errors from avr-dude about device signatures and timing, it's a breath of fresh air – albeit one borrowed from the ARM mbed family.

While the CodeBug concentrates largely on simple educational programming tasks – typically involving animations on the LED matrix – it does have one last trick up its sleeve: an expansion header on the bottom, which can be connected directly to any device that supports the I²C protocol.

It's designed primarily for the Raspberry Pi, although devices without direct I²C support can also be connected via the USB port in 'tethered mode'.

Will the CodeBug replace the Arduino in many hobbyist projects? Unlikely. Is it a good introduction to coding for beginners? I'd say so, and at a price of just £15 inc VAT from <http://cpc.farnell.com> (code SC13932), it doesn't break the bank either. **GPC**

NEWS IN BRIEF

FleaFPGA Uno marries Arduino with FPGA development

The FleaFPGA Uno is the latest development board from Valentin Angelovski, designed to make it cheap and easy to break into field-programmable gate array (FPGA) development. In short, FPGA chips can act like other chips, emulating long-obsolete parts, for example, or acting as entirely novel devices. Based around the Lattice Semi MachXO2, the FleaFPGA Uno boasts an Arduino Uno-like layout, although it's limited to 3.3V logic, so take care with shields, and on-board USB JTAG. The boards are priced at \$50 US, or \$60 US with integrated Wi-Fi. More information is available from Angelovski's website, at <http://fleasystems.com>



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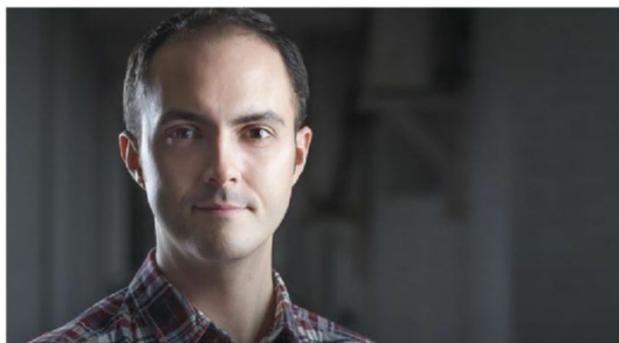
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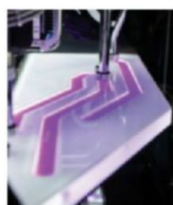
Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

2015 – the best case modding year ever

The sheer amount of PC modding talent on show in 2015 has amazed me. We've seen smaller case manufacturers such as Parvum Systems, Hex Gear and EKWB showcase their products by sending them out to some of the best modders, with some spectacular results – Hex Gear's own Hans Peder Sahl is in Readers' Drives this month (see p108) with his personal project using the company's R40 case. This system is in my top five projects of 2015, but there are numerous other R40 projects that are absolutely stunning too.

Thermaltake has also held several modding competitions, where its Core range of cases featured heavily, and



Frozen Grey, by Daniel Bolognesi (Twister7800GTX)



Tristellar Whetstone, by Alain Simpels



Cooler Master has held similar competitions too. I'm also hearing rumblings various other case makers planning modding competitions for 2016 too. Meanwhile, other modders have been hard at work creating fantastic projects. Purpura by Alain Simpels is another one of my top five projects from this year, using a Dell XPS case along with chrome-plated rigid tubing. Alain has built another fantastic project too, called Tristellar Whetstone, based on Deepcool's three-module Tristellar mini-ITX case.

Another stunning project to surface in recent weeks is Frozen Grey by Daniel Bolognesi, also known as Twister7800GTX. His open-air Corsair

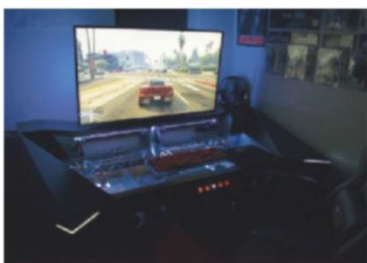
780T project is beautiful, and shows off some of the latest modding techniques too. Peter Brands' latest project – L3pipe – is another project to beat this year too; he was featured in Readers' Drives two issues ago and has drawn considerable interest on Reddit and social media.

Desk PCs have continued to be popular this year too. The latest desk PC to rise up out of the depths of the online forums is from UK modder Rob Deluce, who goes by the pseudonym 'mega-deblow' – his black and super-stealthy

water-cooled beast, called Project Alternate, seemingly takes up half his bedroom. It's just one in a long line of desk PCs we've seen this year, all of which have been very different to Peter Brands' original L3p desk.

Old hands have been at play too – Brian Carter's hotrod PC Cosmos Cruizer is another of my favourites that we've featured this year. Brian has completed several world-class mods and scratch builds in the past decade, and he provides clear proof that you don't need a fancy, complicated scratch-built PC to turn heads in the world of PC modding.

Finally, if you just fancy looking at some eye candy featuring this year's



Project Alternate, by Rob Deluce (mega-deblow), seemingly takes up half his bedroom

best projects, check out my 2015 Mod of the Year article on www.bit-tech.net, where you can see all the greatest talent from the past 12 months.

Modding and water cooling in 2016

This year saw rigid tubing come of age, with both acrylic and metal types becoming a standard choice for anyone wanting to make their PC stand out. Mayhems has recently introduced glass tubing too and, with more sizes and bends now available, as well as its luscious finish, I expect it to become more popular next year. Indeed, the company has a range of new coolants in the works too, and has recently invested in new testing machinery, so it will definitely be one to watch in 2016.

If you're a fan of cases from Parvum Systems or Hex Gear cases, I'm hearing rumblings about both companies having ATX versions of their cases in the works too. Parvum Systems has already shown off

examples of ATX designs using its gorgeous acrylic, and the company has consistently proved its versatility when it comes to changing products to suit customers' needs. For example, Chillblast's Dream PC entry this year featured a longer version of its S2.0 case. The company's own Krait project already uses a prototype ATX case, which you can check out at <http://tinyurl.com/parvum-krait>

Meanwhile, Hex Gear's R40 has featured heavily in the modding scene this year, and the company will likely release an ATX version in 2016 too. The current case is limited to micro-ATX motherboards but it wouldn't need a vast amount of tweaking to enable it to house larger motherboards, and I'd be very interested to see what the Hex Gear guys can do for mini-ITX too. Mind you, the price will be a factor here, as the original R40's heavy use of aluminium already makes it one of the most expensive cases we've reviewed.

Water cooling has also seen a resurgence in 2015, with EKWB, Bitspower and Alphacool all releasing some new and interesting products. EKWB and Bitspower are relentlessly dishing out dozens of motherboard monoblocks for Z170 motherboards, and EKWB has also told Custom PC that it will probably expand its superb Predator line of high-performance all-in-one liquid coolers.

Likewise, Alphacool has focused its attention on the all-in-one liquid cooler market, and I'm super-excited by its GPX-Pro. I finally got my hands on one this month, courtesy of Aquatuning, and while there's little point testing it at the moment, as the company has said it will be improving the performance, I'm impressed with the build quality and the ease with which you could add a CPU waterblock into the loop. It's a shame that only new high-end cards, based on GeForce GTX 980, 980 Ti, Titan X or Radeon Fury GPUs, will be supported for the moment, as I'd definitely consider ditching my custom loop for one of these coolers.

In terms of noise, the pump is super-quiet and easily quieter than any all-in-one liquid cooler I've tested. You wouldn't be able to hear it outside



Parvum's own Krait project already uses a prototype ATX case



EKWB and Bitspower are relentlessly dishing out dozens of motherboard monoblocks for Z170 motherboards

Alphacool's forthcoming GPX-Pro has an incredibly quiet pump, and it uses standard G1/4 connectors, so you could easily replace the tubing, coolant or fittings

of a case, and it's powered by a 3-pin connector too. Hooking up just the pump to a power meter saw it draw just under 4W, which means it should be fine to run it off a standard motherboard fan header too. Meanwhile, the radiator included in my sample appears to be a standard Alphacool 45mm model, with four ports at the top to enable you to treat it as a reservoir as well as a radiator. All the ports included are also standard G1/4 connectors, so you could easily replace the tubing, coolant or the fittings themselves. We'll have to wait until later in 2016 to see the final version, but we'll definitely be one of the first publications to review it. **CPC**



How to Mount a large radiator in your case roof

Want to modify your case to fit a large radiator in the roof? Antony Leather shows you how it's done

 **TOTAL PROJECT TIME** / 3 HOURS

A single or double 120mm-fan radiator is fine for cooling an overclocked CPU, but if you're thinking about cooling your GPU and motherboard too, you'd be well advised to use a larger radiator. As you increase cooling capacity to a triple (or even a quad) 120mm-fan radiator, however, fitting becomes trickier, as some cases only offer single or double fan mounts in the roof. So even if a larger radiator will physically fit in the space, you won't be able to expel air from all the fans.

We've already covered relocating and rewiring your PSU (see p106) to make way for larger radiators, as well as blanking over any 5.25in ports in the front of your case. Now we'll be looking at some final tweaks you can make to clear the path for a monster roof radiator, before cutting out a blowhole, creating mounting points and finally fitting your new radiator and fan grille.

TOOLS YOU'LL NEED



Radiator and grille /
www.mayhems.co.uk



Dremel Trio, holesaw
or jigsaw /
www.amazon.co.uk



Rounded metal file /
Most hardware stores



Masking tape /
Most hardware stores



1 / CHECK CASE FOR PRACTICALITY

If you're willing to ditch some drive bays, and maybe move your PSU, many cases can offer decent water-cooling support. We've already moved our case's top-mounted PSU bracket but, as you can see here, we also need to get rid of a few other items for our radiator to fit.



2 / CONSIDER MOVING PSU

Moving the PSU is easy if it's located in the roof of your case, and it will then free up loads of space in the roof. You can see the full guide in Issue 148, but be sure to also follow the improved wiring guide in this issue on p106.



3 / INSPECT DRIVE BAYS

Drive bays are either riveted in place, or in some cases, as this Lian Li case, they can be screwed in place too. If you need to hold the 5.25in slot cover in place afterwards, follow our drive bay blanking guide in Issue 147.



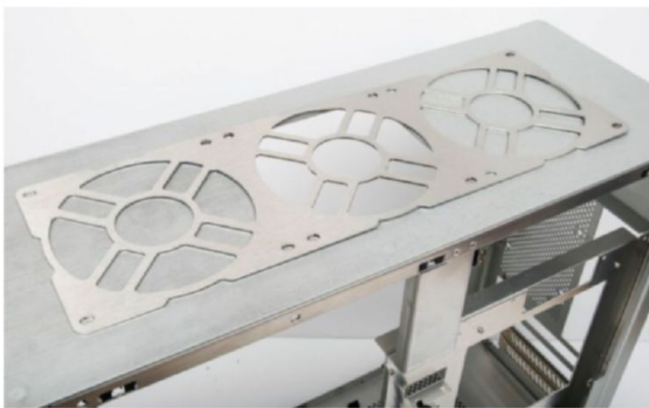
4 / REMOVE DRIVE BAYS

Our drive bays use screws, but you can also drill out rivets fairly easily, using a Dremel with a drill attachment or a standard power drill. If you end up using a power tool, apply some masking tape to the area so you don't scratch the case.



5 / REMOVE OTHER FITTINGS OR MOUNTS

Our case has a roof fan mount and grille that blocks the radiator and you'll need to remove any such parts. In our case, the fan mount also strays into our new radiator fan grille's mounting position, so check these areas on your case before you start cutting.



6 / TEST-FIT GRILLE

Our grille happened to fit perfectly with the existing fan blowhole – it's worth using any existing blowholes if you can, as it will save you a lot of work.



7 / APPLY MASKING TAPE

Applying masking tape to the area prevents you from scratching the case with your cutting tools and files, and it also allows you to mark up the case with a pen without marking the chassis – an important factor if you don't plan to paint your case afterwards.



8 / MARK UP RADIATOR GRILLE

Now mark up the areas you need to cut out. Don't make more work for yourself by cutting out the individual grille patterns – just mark up the entire circles under the grille, as well as the fan mounting points.



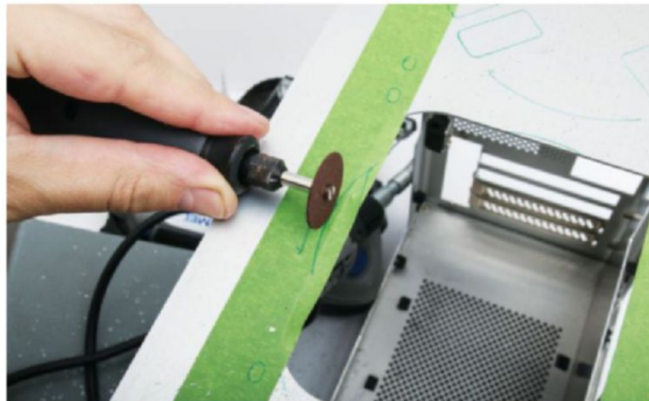
9 / USE A HOLESAW

We'll be using a Dremel Trio, but you can also use a drill with an appropriately sized holesaw to cut out circles. Be warned, though, that some grilles have holes smaller than 120mm (ours was around 110mm), and cutting through steel can take some work.



10 / USE A JIGSAW OR DREMEL TRIO

A Dremel Trio is a great tool for getting the job done quickly, or you could alternatively use a jigsaw or a Dremel rotary tool with a cutting disc attachment.



11 / USE DREMEL FOR FINER CUTS

Depending on your grille's pattern, you may want to use a Dremel rotary tool and cutting disc to cut around the finer edges of the fan blowholes – a Trio or Jigsaw can be a little clunky in these areas.



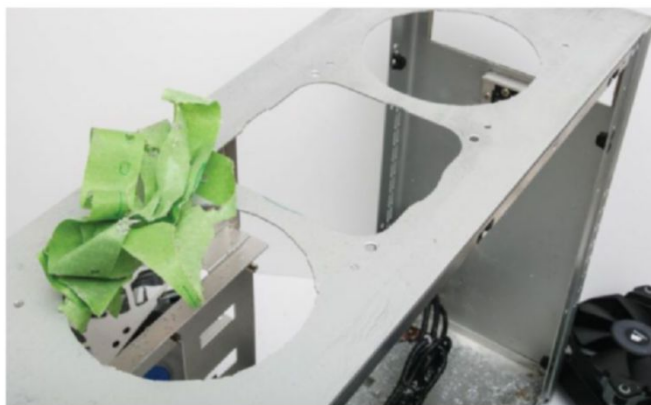
12 / DRILL MOUNTING HOLES

With the fan blowholes dispatched, use an appropriately sized drill bit to cut out the radiator mounting holes.



13 / FILE EDGES

Most methods of cutting metal leave behind sharp edges and you'll need to spend a few minutes filing them down to remove all the sharp shards. This process will prevent you from accidentally cutting yourself, and stop any shards falling into your case afterwards.



14 / REMOVE MASKING TAPE

The masking tape will probably have picked up a lot of metal shards, so remove it carefully by peeling from it from one edge, then place it straight in a bin. After that, use a Hoover to clean up any other metal fragments from your case and working area.



15 / MOUNT RADIATOR TO CASE

It's usually best to mount the radiator as an exhaust, so a single set of fans is best placed to blow air into the radiator from below. If you want to see some fan logos and blades, though, you could install a second row of fans, or mount fans to the top in a 'pull' configuration. **GPC**

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How to Wire up a relocated PSU securely

AMENDMENT

Before following our PSU relocation guide from Issue 148, read this guide by Antony Leather to ensure you have a safe and secure power connection



TOTAL PROJECT TIME / 1 HOUR

Last month, reader Matthew Voisey gave us some feedback about our PSU relocation guide from Issue 148. In the guide, we showed how to move your PSU mount inside your case to make room for other components, such as larger radiators. This process involved creating a custom bracket inside the case, blanking over the old one and finally wiring up a female power lead socket.

Matthew's comments concerned the way we attached the cables to the port, where we wrapped the cables around the connectors, then insulated them with insulating tape.

However, a more secure and safer method of wiring up the socket is to use solder with insulating heatshrink covers or insulated spade connectors. In this guide, we'll show you how to wire up your PSU with this method, so you can follow the rest of the PSU relocation guide and end up with a more secure setup.

TOOLS YOU'LL NEED



Cable crimp tool (for either insulated or non-insulated connectors) / Most hardware stores



Solder and soldering iron (for non-insulated connectors) / Most hardware stores



Female spade connectors (insulated or non-insulated) / www.amazon.co.uk

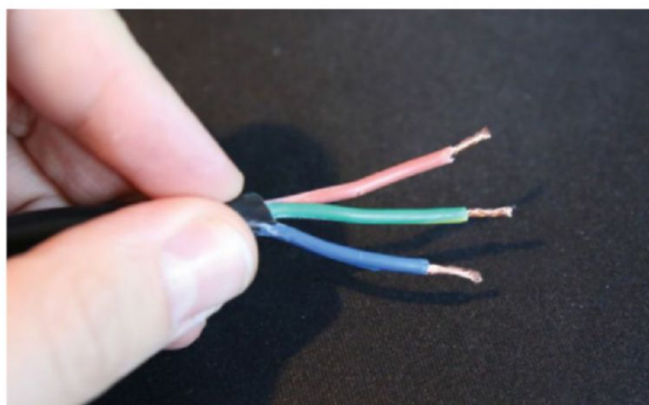


Electrical heatshrink (for non-insulated connectors) / www.amazon.co.uk



1 / CHECK CABLE WIDTHS

To use insulated spade connectors, check the width of your power lead's cables, which is usually written on the lead. Typically, you'll either need red or blue connectors – the former catering for 0.4mm² (22–16awg) widths, the latter for 1.1–2.6mm² (16–14awg) widths.



2 / STRIP BACK CABLES

Once you've cut off the plug section, strip back the sheath by 1in to allow the cables to reach the new power connector, then strip off around 5mm of sheath from each of the three cables.



3 / TEST-FIT SPADE CONNECTORS

Before you connect the spade connectors, check they fit the male pins on the power connector. They should require some force to be removed. If they're too loose, you can slightly compress the rolled-over ends to create a tighter fit.



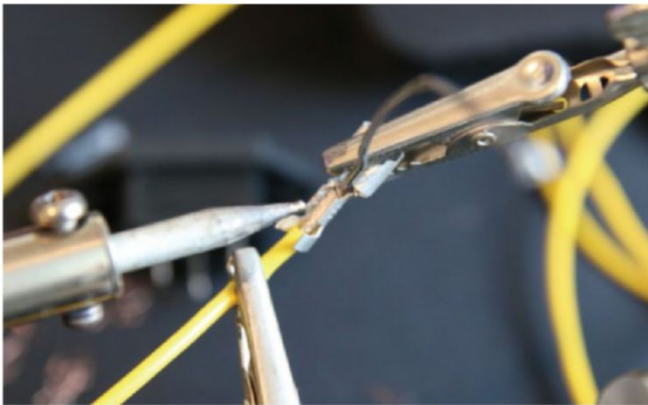
4 / PUT INSULATED CONNECTOR IN CRIMP TOOL

Insulated and non-insulated spade connectors have different crimping tools, but the process is the same. There's a wide gap in the crimp edge for the large end and a narrower one for the inner flanges – insert the connector so that both sections are crimped.



5 / CRIMP CONNECTOR

Squeeze the tool so it holds the connector in place. Insert the cable so that you can just see the end poking out of the end of the connector, then fully compress the crimping tool. The connector will then be held on, so you can't pull it off.



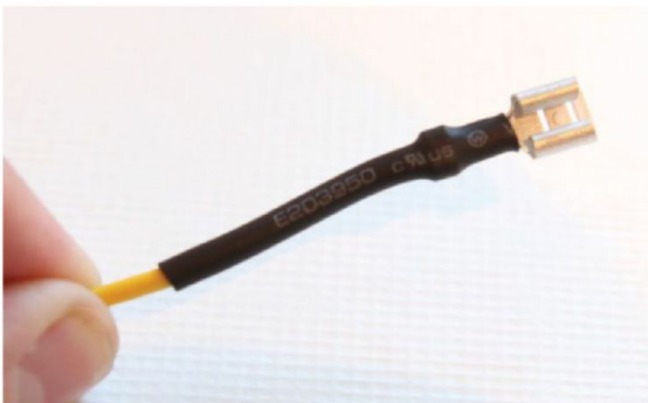
6 / SOLDER CABLE TO UNINSULATED CONNECTOR

Non-insulated connectors are crimped similarly, although they also give you the opportunity to solder them the cable to make a firmer connection, which you can't do with insulated connectors. Insert the cable so that the wire sits under the inner flanges, then apply solder.



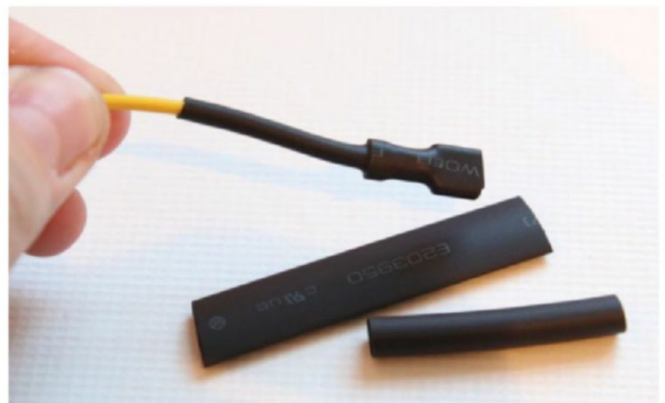
7 / CRIMP CONNECTOR

Using a non-insulated crimping tool, place the connector into the jaws of the tool so the larger end piece fits into the larger gap in the tool. Apply plenty of pressure until the tool is completely compressed. Both grips should be crimped, holding both the sheath and cable in place.



8 / APPLY HEATSHRINK

You now need to cover the uninsulated cables using the appropriately sized wire heatshrink. We've used 3.5mm heatshrink to fit over the cable and base of the connector. Slip it over the cable, then heat it with a lighter or a gas hob on low heat until it shrinks and fits tightly.



9 / COVER CONNECTOR

After that, cover the connector in slightly larger 7mm heatshrink, which creates seamless insulation from the cable sheath to the end of the connector, meaning nothing is exposed. **GPD**

Readers' Drives

Engineering Station

After cofounding case manufacturer Hex Gear, Hans Peder Sahl decided to mod an R40 case to make a water-cooled 8-core workstation

CPC: What originally inspired you to build Engineering Station?

Hans: As some of you may know from previous interviews, a buddy of mine (Nate George) and I started our own case company Hex Gear around a year ago, and I also wanted to build a beast of a system that could replace my primary rig using the Hex Gear R40 as the base. I started out thinking of building a simple workstation with plenty of

power. I wanted to make it easy to swap out parts and, for a brief moment, I considered just going with air cooling. I'm not very good at keeping things simple, though, so the project soon spiralled out of control with all sorts of ideas.

CPC: Where did the name come from?

Hans: Engineering Station is the name of a building in one of my favourite RTS games, Supreme Commander. When you build an Engineering Station, it then helps you build other stuff, much like this PC will

do for me. On top of that, I thought Engineering Station was a fitting term for its main workloads, as I work with a lot of 3D-related stuff.

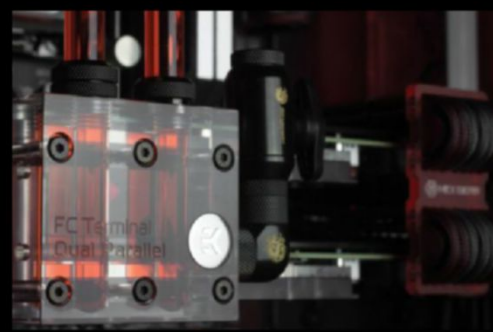
CPC: What specs did you choose?

Hans: The system is built around an Intel Core i7-5960X, an £800 processor with eight physical cores and 16 threads. This CPU is an absolute beast, and it greatly improves the time it takes me to render pictures and video. I had a Core i7-4770K in my previous rig, and I got really tired of the time it took to render pictures, so I knew I wanted a more powerful CPU in my next rig. I also wanted to be able to max out all the settings in my games, so I went with two GTX 980 Ti cards, instead of, for example, a Quadro workstation card, which would be horrible for gaming.

CPC: What other mods have you built?

Hans: Five, if we only count the big ones – PC-Beto, Project M8, Project NV, Experiment nr. 5 and the R40 ROG Edition. I've also built a few show rigs for Nvidia and other companies. I mostly build PCs for fun, so the purpose of them is just to see how far I can push the limits. I learned years ago that you should never mod your primary PC, so I've always modded a second PC, which I can then use as my primary PC when it's done, then mod another system and so on – this scheduling gives me plenty of time to tinker around with the mods.

I always try to implement new techniques and features in my mods, so they don't just become assembly-line case mods that use the same techniques and styles. For example, in this build, I focused on extreme cable management, which hadn't been a focus of my previous mods.



CPC: What difficulties did you come across?

Hans: The main problem was cable management. From the start, I knew I'd have to come up with a clever way of making the cables look good, while also remaining practical. I made a laser-cut acrylic plate with 3.3mm holes in it, and a number at each hole, so I'd know exactly where to route each cable.

Another issue was the water-cooling loop. I'd already thought about routing all the tubes outside the case, down the back and then into the case again to keep the innards clean. Originally, I just wanted to build this loop using fittings and hard tubing, but then I played around with the idea of a fully milled acrylic block on the back that would do this job instead. The result is the same in terms of function, but it looks so much better, and it also means I don't have to worry about tubes on the back accidentally breaking, as it's now one solid piece.

CPC: What materials did you use?

Hans: I remade a lot of the internal case parts to fit my needs exactly, cutting them from acrylic, steel and



/MEET THY MAKER

Name Hans Peder Sahl

Age 27

Location Esbjerg, Denmark

Occupation CTO at Hex Gear

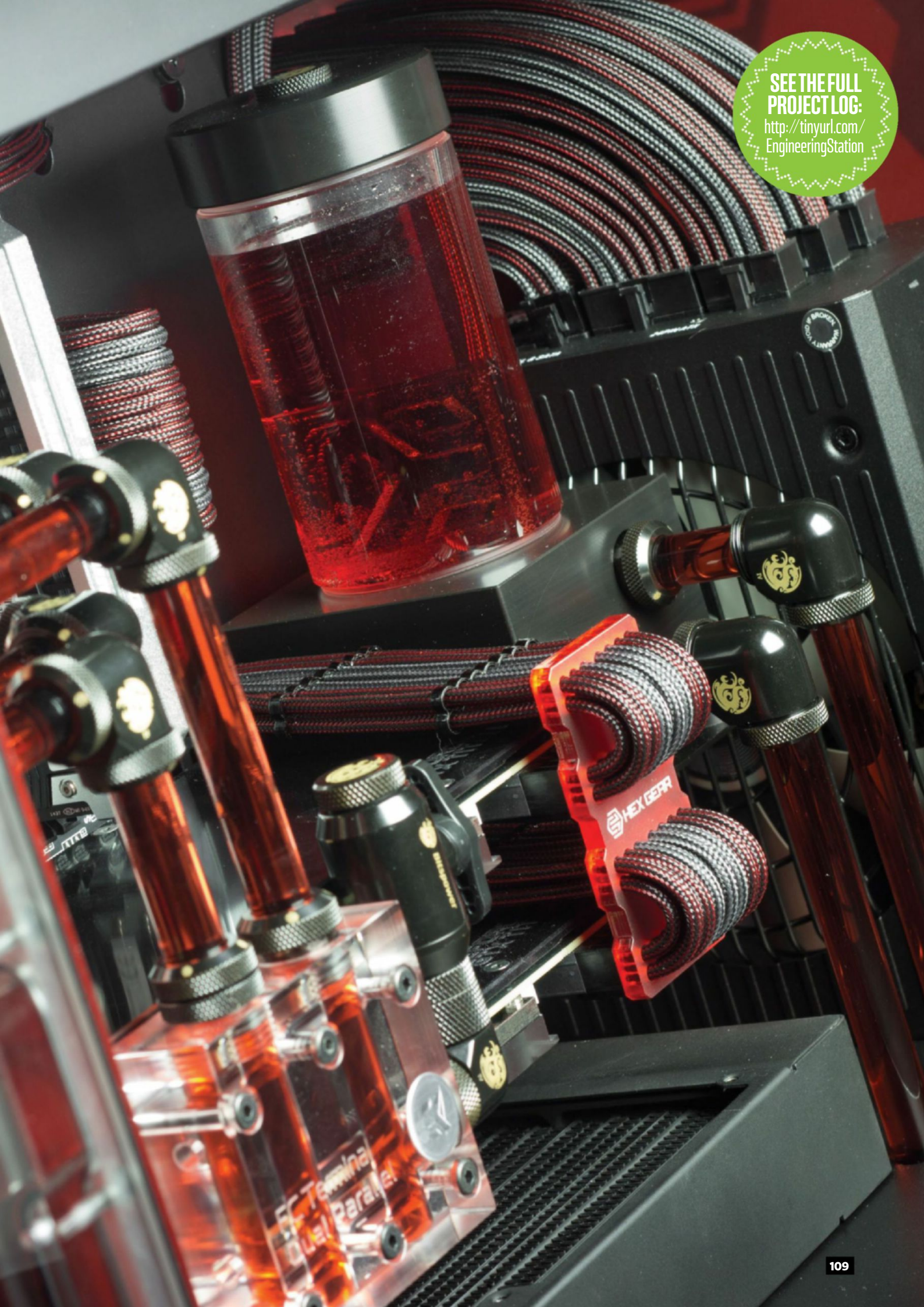
and R&D engineer at BPI

Main uses for PC 3D modelling, 3D rendering, video rendering and, of course, gaming

Likes Cooking, diving, travelling, gaming, modding, and generally building and creating stuff

Dislikes The waiting time for the new Star Wars movie

SEE THE FULL
PROJECT LOG:
[http://tinyurl.com/
EngineeringStation](http://tinyurl.com/EngineeringStation)





aluminium. I also used a 25mm-thick block of acrylic for the rear water-cooling block. This block was then milled by a good friend of mine, Peter Urhskov Berg, who really knows his way around programming and working with CNC machines. I have to say that milling this block was a super-fun experience; it's always fascinating to see a solid block being turned into a product you imagined in your head, and until that point, you had only seen on a screen.

The rest of the custom parts where mainly made from acrylic, such as the cable comb for the GPUs, which I designed. I couldn't find a product that suited my needs for this job, so I designed a special comb that allows the graphics card power cables to turn 180 degrees and lay cleanly flat over the graphic cards. I can't begin to tell you how much easier this comb makes cable management for graphics cards, and I think this concept will be used in lots of other projects.

CPC: What tools and machinery did you use?

Hans: I used all sorts of tools and machinery, from small needle files and manual drills, to advanced CNC machines and laser cutters. I really like to use all sorts of technologies to make my mods. Even though lots of the parts for my mods are made on very expensive machines, I still sit in my basement and hand-make certain parts, and sometimes spend hours hand-filling a fitting so that it will fit into a certain location. It's fun to work with CNC machines,



but making a product with your bare hands also provides a unique satisfaction that you don't get anywhere else.

CPC: What media interest has Engineering Station attracted?

Hans: It's already had lots of views and attention on forums, Facebook, Reddit and YouTube. On Reddit, it even became the fourth most upvoted submission of all time on both /r/ cablemanagement and /r/ cableporn, which makes me proud.

CPC: How long did the build process take?

Hans: Around five months, but most of this time was spent waiting for components to arrive. In terms of the actual build time, though, the cabling was definitely a time sink, taking around 35 hours alone.

CPC: What did you learn from the build process?

Hans: I've learned a great deal about CNC machines, and I also

think I've greatly improved my cable management skills. I now can't wait to get started on some more projects!

CPC: Are you happy with the end result, and is there anything you'd do differently if you built it again?

Hans: I'm super-happy with the end result, and I smile each time I look at Engineering Station standing on my desk. It just runs so perfectly, and it's super-quiet too. The Aquaero fan controller also keeps my mind at ease, since it adjusts the fan speeds when the water temperature goes up. I don't really think there's anything I'd change if I had to build it again. In my mind, it's as good as I can make it. If I had to make it look cooler, though, I would make an interconnect block for it, much like the one I made for Project NV and Experiment nr. 5, but that would also make changing the CPU or RAM a nightmare, so I decided to keep it simple in this mod. **CPC**

BE A WINNER

To enter your machine for possible inclusion in Readers' Drives, your mod needs to be fully working and, ideally, finished based in the UK. Simply log on to www.bit-tech.net and head over to the forums. Once you're there, post a write-up of your mod, along with some pics, in the Project Logs forum. Make sure you read the relevant rules and advice sticky threads before you post. The best entrant each month will be featured here, where we'll print your photos of your project and also interview you about the build process. Fame isn't the only prize; you'll also get your hands on a fabulous selection of prizes – see the opposite page for details.

SYSTEM SPECS

Case Hex Gear R40

CPU Intel Core i7-5960X

Graphics card 2 x Nvidia GeForce GTX 980 Ti

Memory 32GB Corsair Dominator Platinum DDR4 2666MHz

Motherboard Gigabyte X99M-Gaming 5

Storage 256GB Corsair Neutron GTX SSD, 6TB Western Digital Red hard drive

PSU Corsair HX1000i

Cooling Custom water-cooling loop with EK waterblocks and Bitspower fittings

Win all these prizes!

We've teamed up with some of the world's leading PC manufacturers and retailers to offer this great range of prizes to each lucky Readers' Drives winner. If your creation is featured in the magazine then you'll walk away with all of the prizes listed on this page, so get in your entries!

Corsair graphite Series 230T case and RM 550w Modular power supply

TOTAL VALUE £150 inc VAT / **MANUFACTURER** www.corsair.com

Corsair believes that a great PC starts with a great case. The Corsair Graphite Series 230T is a compact expression of this core philosophy. With stylish looks and a choice of three different colours, it packs in a remarkable number of features to provide builders with tonnes of room for expansion and amazing cooling potential. Like all Corsair cases, it's built using the finest materials and finished to the highest standards, so it will withstand several years of upgrades. Plus, to make sure it stand out from the crowd, the 230T features Corsair's new Air Series LED high-airflow fans, providing distinctive lighting with low-noise, high-airflow cooling.

Just as a quality case is essential to building a quality PC, a high-performance, a high-quality power supply is also a vital ingredient. The all new RM series has been built from the ground-up to deliver unmatched reliability alongside 80Plus Gold efficiency, and all with the absolute minimum of noise. It uses specially optimised quality parts to reduce sound at the component level, and it's completely silent below 40 per cent load, thanks to its Zero RPM fan mode. It's also fully modular, allowing for the maximum amount of flexibility during installation. With a Corsair Graphite 230T case and an RM 550W Modular power supply at the heart of your build, you'll have the foundations for a truly awesome gaming machine.



Mayhems coolant and dyes

VALUE £50 inc VAT / **MANUFACTURER** www.mayhems.co.uk



Cooling performance is only one part of the equation when it comes to kitting out your rig with custom water-cooling gear. The other major bonus is that all those tubes and gleaming fittings just make your PC look damn sexy, and they look even better when they're pumped full of fancy coloured coolant. As such, we're particularly pleased to have the folks at Mayhems now on board with Readers' Drives; they're currently offering two 1-litre bottles of Mayhems' Pastel Ice White coolant, along with a selection of five dyes, so you can choose the colour that best complements your PC. Check out the blue coolant in our own mini PC mod on the cover of Issue 109 for an example of what's possible with some Mayhems coloured coolant.

Phobya Modding Kit

VALUE £50 inc VAT **MANUFACTURER** www.phobya.com, www.aqua-tuning.co.uk

The Phobya modding kit is designed with the modder in mind, offering great value for money and quality products. The kit includes Nano-G 12 Silent Waterproof 1,500rpm multi-option fans, which use an innovative fan-blade design. As standard, the fans include braided black cables to keep your case looking as neat as possible. The fans are also supplied with a special cable that lets you run the fan at 5V rather than 12V, reducing the noise emitted in order to help you to build a silent system.

The kit also includes the 60cm Phobya 3-pin Molex to 4x 3-pin Molex Y-cable. This pre-

braided extension cable gives you extra routing options in your case, and it also enables you to run up to four fans from one compatible

motherboard header. Meanwhile, the Phobya SATA 3 cables included in the kit offer the same great quality braiding as the rest of the Phobya range, while also securing your connection with latched connectors.

As well as this, the kit includes the Phobya SlimGuide Controller, which gives you the option to vary the speed of other fans in your case, while the Phobya TwinLEDs let you shine a light on your mods.



CUSTOM PC

REALBENCH 2015

in association with **ASUS**

Give your PC a workout with our new benchmark suite, and see how your rig compares to other readers' machines

BENCHMARK YOUR PC

Download the benchmarks from www.asus.com/campaign/Realbench and, before you run them, disable any power-saving technologies in your BIOS that change your CPU clock speed, or the leaderboard won't record your overclock frequency properly. To post a score on the leaderboard, go to Save Upload File in the RealBench 2015 app's Results menu, and save your results in an RBR file. You need to select Offline Uploads on the leaderboard site, sign up for an Asus account and upload your file.

Gimp

We use Gimp to open and edit large images. Unlike our previous Gimp test, this one uses more than one CPU core, although it's still more sensitive to clock speed increases than more CPU cores.

Handbrake H.264 video encoding

Our heavily multi-threaded Handbrake video encoding takes full advantage of

many CPU cores, pushing them to 100 per cent load.

LuxMark OpenCL

This GPU compute test is the only synthetic part of our suite, although the renderer is based on the real LuxRender physically based rendering software. As 3D rendering is a specific workload that not everyone will use, and because OpenCL support isn't standard in most software, this section is given just a quarter of the weighting of the other tests in the final score.

On an Intel system, the 100 per cent reference score comes from a stock-speed Core i7-4790K, with 16GB of Corsair 2,400MHz DDR3 memory, a 240GB OCZ 150 SSD, an Asus Maximus Gene VII motherboard and an Nvidia GeForce GTX 780 3GB graphics card.

On an AMD system, the 100 per cent reference score comes from a stock-speed A10-7850K APU, with 8GB of Corsair 2,133MHz DDR3 memory, a 256GB Plextor M5 Pro SSD and an Asus A88X-Pro motherboard, using the APU's integrated graphics. **CPC**

VERSION 2.42 AVAILABLE

The dev team at Asus has released a revised version of benchmarks with a few fixes, including new hardware support and preventing the app from crashing if you try to close it while it's collecting system specifications. You can download RealBench 2015 version 2.42 from www.asus.com/campaign/Realbench now.

Heavy multi-tasking

Our new multi-tasking test plays a full-screen 1080p video, while running a Handbrake H.264 video encode.

Scores

RealBench 2015 breaks down the scores for each test, then gives you a total system score and a percentage reference score.

CHROME WARNING

At the moment, Google's Chrome browser flags up the RealBench 2015 download as potentially harmful, and we're aware of this issue. The file is perfectly safe, however – please ignore this warning.

CUSTOM PC REALBENCH 2015 LEADERBOARD

RANK	SYSTEM SCORE	REFERENCE	USERNAME	MOTHERBOARD	CPU	CPU CLOCK	MEMORY	PRIMARY GPU
1	275,683	240.9%	8pack	Asus Rampage V Extreme	Intel Core i7-5960X	5.5GHz	16GB Kingston 3000MHz	Nvidia GeForce GTX Titan X
2	233,375	203.9%	ian.parry3	Asus Rampage V Extreme	Intel Core i7-5960X	4.6GHz	32GB G.Skill 3200MHz	Nvidia GeForce GTX Titan X
3	231,781	202.5%	CustomPC	Asus Rampage V Extreme	Intel Core i7-5960X	Not reported	16GB Corsair 2666MHz	Nvidia GeForce GTX Titan X
4	219,638	191.9%	Chris_Waddle	Asus X99 Deluxe	Intel Core i7-5960X	4.6GHz	16GB Corsair 3000MHz	Nvidia GeForce GTX Titan X
5	219,415	191.7%	Luke@DinoPC	Asus Rampage V Extreme	Intel Core i7-5960X	4.6GHz	16GB Corsair 3276MHz	Nvidia GeForce GTX Titan X
6	215,694	188.5%	dubai1	Asus X99-Pro/USB 3.1	Intel Core i7-5960X	4.7GHz	32GB Corsair 2800MHz	Nvidia GeForce GTX 980 Ti
7	206,723	180.6%	stuart	Asus Rampage V Extreme	Intel Core i7-5960X	4.41GHz	16GB Corsair 3000MHz	Nvidia GeForce GTX 780 Ti
8	197,964	173%	Carbonleg	Asus X99-E WS	Intel Core i7-5960X	Not reported	32GB Corsair 2400MHz	AMD Radeon R9 200 Series
9	189,230	165.3%	shadowrayne	Asus Rampage V Extreme	Intel Core i7-5960X	4.2GHz	32GB Corsair 2133MHz	Nvidia GeForce GTX 980
10	185,219	161.8%	dax	Asus Rampage V Extreme	Intel Core i7-5960X	3.97GHz	32GB Corsair 2448MHz	Nvidia GeForce GTX 980
11	179,386	156.7%	mboogie	Asus Rampage V Extreme	Intel Core i7-5960X	4.2GHz	32GB Crucial 2133MHz	Nvidia GeForce GTX 980
12	175,745	153.6%	dis80786	Asus Rampage V Extreme	Intel Core i7-5930K	4.4GHz	16GB Corsair 2666MHz	Nvidia GeForce GTX 970
13	173,154	151.3%	mark.gee93	Asus Rampage V Extreme	Intel Core i7-5930K	4.49GHz	12GB Corsair 3168MHz	Nvidia GeForce GTX 980 Ti
14	172,828	151%	mdottwo	Asus Rampage V Extreme	Intel Core i7-5820K	4.4GHz	16GB G.Skill 2766MHz	AMD Radeon R9 200 Series
15	167,332	146.2%	grozzie	ASRock X99M Killer	Intel Core i7-5930K	4.48GHz	32GB Kingston 3071MHz	AMD Radeon R9 200 Series
16	167,002	145.9%	maliepaard.chris	MSI X99S SLI Plus	Intel Core i7-5820K	4.49GHz	16GB Corsair 3000MHz	Nvidia GeForce GTX 980 Ti
17	165,512	144.6%	Penfold	Asus X99-Deluxe	Intel Core i7-5820K	4.5GHz	32GB Corsair 2333MHz	AMD Radeon R9 200 Series
18	163,650	143%	shaunhanson	MSI X99S SLI Plus	Intel Core i7-5820K	Not reported	16GB Corsair 2133MHz	Nvidia GeForce GTX 980
19	163,400	142.7%	andy	MSI X99S Gaming 7	Intel Core i7-5820K	4.4GHz	16GB Corsair 2666MHz	Nvidia GeForce GTX 980
20	163,065	142.5%	viperz	Asus X99-Deluxe	Intel Core i7-5820K	4.48GHz	16GB Corsair 2400MHz	Nvidia GeForce GTX 970

Folding@Home

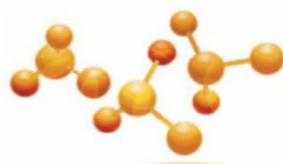
Join our folding team and help medical research

MILESTONES THIS MONTH

USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE
fafchef	20000	bastardo_bill	900000	bigrew	6000000	Portchylad	50000000
crazeey	40000	mort6dav3	900000	kiiight	6000000	Tattysnuc	50000000
Capt-Camm-Nett	70000	salmonbread	900000	b1ll55t34m	7000000	Andy_J	60000000
whiskeyecho	70000	Valkerie69	900000	NikolaiDante	8000000	daxchaos	70000000
JCL1987	100000	alien_ghost	1000000	techknowledgy	8000000	Maglor	70000000
BenScoobert	200000	anfortis	1000000	Jon_Simmo	9000000	BeezaBob	80000000
mar_duke	300000	FurstyFerret	2000000	Liam266	9000000	mmorr	100000000
Mr_Blue_Jam	300000	Just_G	2000000	_centurion_	10000000	KevinWright	200000000
valkynaz	300000	MrDevious	2000000	cauliflower1	20000000	Laguna2012	300000000
Ayeska	400000	scoobyzilla	2000000	MattEngr	20000000	Lordsoth	400000000
p1ngu_666	400000	arcitech1	3000000	Qazax	20000000	Slavcho	400000000
Anselm	500000	tastyradiskull	3000000	Keith_Whi	30000000	PC_Rich	500000000
roosauce	500000	PURE	4000000	Trunkey	30000000	HHComputers	700000000
grozzie	600000	QuasarGreg	4000000	madmatt1980	40000000	piers_newbold	700000000
Hounddog	700000	kornvdd	5000000	slowpurple	40000000		

WHAT IS FOLDING?

Folding@home uses the spare processing cycles from your PC's CPU and graphics cards for medical research. You can download the client from <http://folding.stanford.edu> and our team's ID is 35947. Once you pass a significant milestone, you'll get your name in the mag. You can also discuss folding with us and other readers online at the www.bit-tech.net forums.



TOP 20 OVERALL

RANK	USERNAME	POINTS	WORK UNITS
1	Nelio	2,484,738,312	158,296
2	DocJonz	1,586,583,788	183,055
3	coolamasta	825,757,144	176,546
4	HHComputers	744,151,858	30,945
5	Scorpuk	725,144,823	30,658
6	piers_newbold	724,041,918	46,444
7	StreetSam	570,985,851	90,228
8	PC_Rich	521,131,564	81,185
9	Dave_Goodchild	465,859,327	119,894
10	johnim	459,583,120	81,916
11	Lordsoth	405,596,203	97,883
12	Slavcho	403,805,082	35,988
13	The_M2B	345,788,871	60,623
14	Laguna2012	302,151,268	23,838
15	phoenicis	250,044,587	95,660
16	Desertbaker	250,016,610	19,694
17	TheFlipside	216,244,051	22,869
18	KevinWright	213,558,862	31,035
19	Wallace	212,477,027	6,204
20	zz9pzza	211,014,628	15,794

TOP 20 PRODUCERS

RANK	USERNAME	DAILY POINTS AVERAGE	OVERALL SCORE
1	HHComputers	5,851,334	744,151,858
2	DocJonz	3,884,435	1,586,583,788
3	piers_newbold	1,768,175	724,041,918
4	Laguna2012	1,577,826	302,151,268
5	Lordsoth	1,489,910	405,596,203
6	Nelio	1,296,278	2,484,738,312
7	PC_Rich	1,135,696	521,131,564
8	Dickie	1,123,551	169,648,999
9	daxchaos	1,095,135	71,533,658
10	Slavcho	996,702	403,805,082
11	KevinWright	865,125	213,558,862
12	The_M2B	805,119	345,788,871
13	Desertbaker	780,243	250,016,610
14	coolamasta	703,869	825,757,144
15	johnim	640,121	459,583,120
16	madmatt1980	600,677	40,123,551
17	BeezaBob	592,926	82,572,629
18	Tattysnuc	492,171	57,890,114
19	Roveel	490,684	151,149,510
20	_centurion_	475,049	19,556,787



JAMES GORBOLD / HARDWARE ACCELERATED

THE LOUNGE PC CONCEPT IS FLAWED

Media Center, Viiv and LIVE! failed because living room PCs are ultimately undesirable, argues James Gorbold

For decades, the industry has been desperate to move our PCs from the study/second bedroom into the living room. Microsoft pushed Media Center for many years, starting with a special edition of Windows XP before finally giving up after Windows 8. Intel ploughed millions into Viiv, a collection of technologies that was supposed to create a level playing field for media PCs, but got bogged down by terrible DRM and a lack of software support. AMD also tried with LIVE!, which failed even quicker than Viiv because of its lack of supported media content.

Valve has also now released SteamOS, a Linux-based alternative to Windows for lounge gaming. However, while the interface is easy to use, Valve still has to convince more software developers to recompile their games and applications for it – the SteamOS games library is small compared with Windows.

So why have such titans of the industry all failed to make the living room PC a success? Early attempts at living room PCs were embarrassingly large and clunky, being more than five times the size of any set-top box. Even now, with the advent of mini-ITX motherboards, most compatible cases are far too large or are hindered with immature ‘gamer’ design features that no self-respecting adult would want in their living room. In addition, as soon as you stick high-performance components in a mini-ITX case, they will invariably run hotter and louder than when installed in a well-ventilated micro-ATX or ATX case. The other big issue with mini-ITX components is cost, with many of the principal components – motherboard, case and power supply – costing significantly more than

equivalent-spec micro-ATX or ATX alternatives. And, of course, for the average consumer, all of the above is compounded by such PCs costing far more than consoles.

However, even if these design and cost challenges were solved, I’m not convinced PC enthusiasts would flock into the living room. Games have to trick your brain into forgetting you’re staring at a multi-coloured light bulb, and that you’re really shooting Nazis, slashing at orcs or dogfighting spaceships. I know console gamers are happy gaming in front of the TV but, when I’m sitting on a sofa, looking at a TV on the other side of the room, I find my brain getting distracted by everything else going on around me.

VR headsets, when they launch later this year, will help solve the problem of immersion. However, you’ll need a high-end PC to enjoy a VR headset, and that currently isn’t practical in a case that’s quiet, small and good-looking enough to be in your living room.

The world’s best game controller, the keyboard and mouse combo, is also pretty useless in the living room, thanks to the lack of hard surfaces and anywhere to rest your wrists. Corsair does have an answer to this problem with its Lapdog keyboard and mouse stand that sits on your lap, although gamers such as myself, who use wired peripherals, will still have to string USB cables across the living room.

It comes as no surprise to me that sales of living room PCs, be they simple media PCs or more powerful gaming PCs, have never really taken off, with sales that represent a tiny fraction of the sales of full-sized PCs. It isn’t so much the technology per se, but that the overall concept is flawed and undesirable. **GPC**

Early attempts at living room PCs were embarrassingly large and clunky

James Gorbold has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.

THE ALL-NEW ROCCAT KOVA



STREAMLINED PHILOSOPHY

ROCCAT's all new Kova gaming mouse is the high speed gaming tool for players who value execution over flash. Optimized for both left and right-hand use, with a simple, sleek, high-performance design, the Kova provides a fine-tuned sports car vibe in the body of an impressively engineered mouse. Smart Cast technology provides twice the advantage, with an optimally placed button layout that doubles up on your standard mouse 1 and mouse 2 functions.

Within fingertip reach, Smart Cast adds reflexive control for fast-paced games. 72MHz Turbo Core V2 32-bit ARM-based MCU also provides a dpi 1-2 punch we call Overdrive Mode. Get creative with two-level, 16.8M multicolor illumination, and double the effects with ROCCAT Talk + AlienFX. Finally, ROCCAT SWARM software under the hood keeps your games, apps and ROCCAT gear synced, making the all new Kova a Future Ready must have.



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GAMING MOUSE

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NVIDIA SHIELD TABLET K1 - THE ULTIMATE TABLET FOR GAMERS

The new NVIDIA® SHIELD™ tablet K1 is a high-performance tablet that brings ultimate entertainment to gamers. Together with the SHIELD controller and GeForce NOW™ cloud gaming service, this Android tablet is instantly transformed into a powerful gaming system that can create the best experiences in the gaming world.



STRAFE RGB Mechanical Gaming Keyboard - Cherry MX Silent Keys

Strafe RGB MX Silent delivers ultra-quiet mechanical key switch performance and dynamic multicolor lighting control. It's up to 30% quieter than other mechanical gaming keyboards without sacrificing the speed, feel and responsiveness you need to win, and with virtually unlimited backlighting customization it looks as great as it plays.



Intel® Core™ i7 6700K 6th Generation Intel® Core™ Processor

Take control with the 6th Generation Intel® Core™ processors codenamed "Skylake-S". The i7 6700K is the flagship processor of the Skylake-S line-up that features exceptional performance that is increased by up to 22% and offers 6x faster storage bandwidth for quicker media access, all this means for an all-round more responsive PC.



Don't buy hardware without **Scansure** protection. 28 day installation damage insurance www.scan.co.uk/scansure.



Scan Finance. Buy now, pay 10% deposit* and spread the cost over 36 or 48 months when you spend £300 (inc vat) or more.

Prices correct at time of print. Classic credit options (36 or 48 months). Customers will initially only have to pay a 10% deposit, with the original loan amount payable over 36 or 48 months.
*Example: £1,000.00 Deposit: £100.00 Amount of loan: £900.00 Total charge for credit: £276.12 Total payable: £1,276.12 Total 36 Monthly instalments of: £32.67 APR: 19.9%. Terms and Conditions Apply.